ENGINEERING

An Illustrated Weekly Journal.

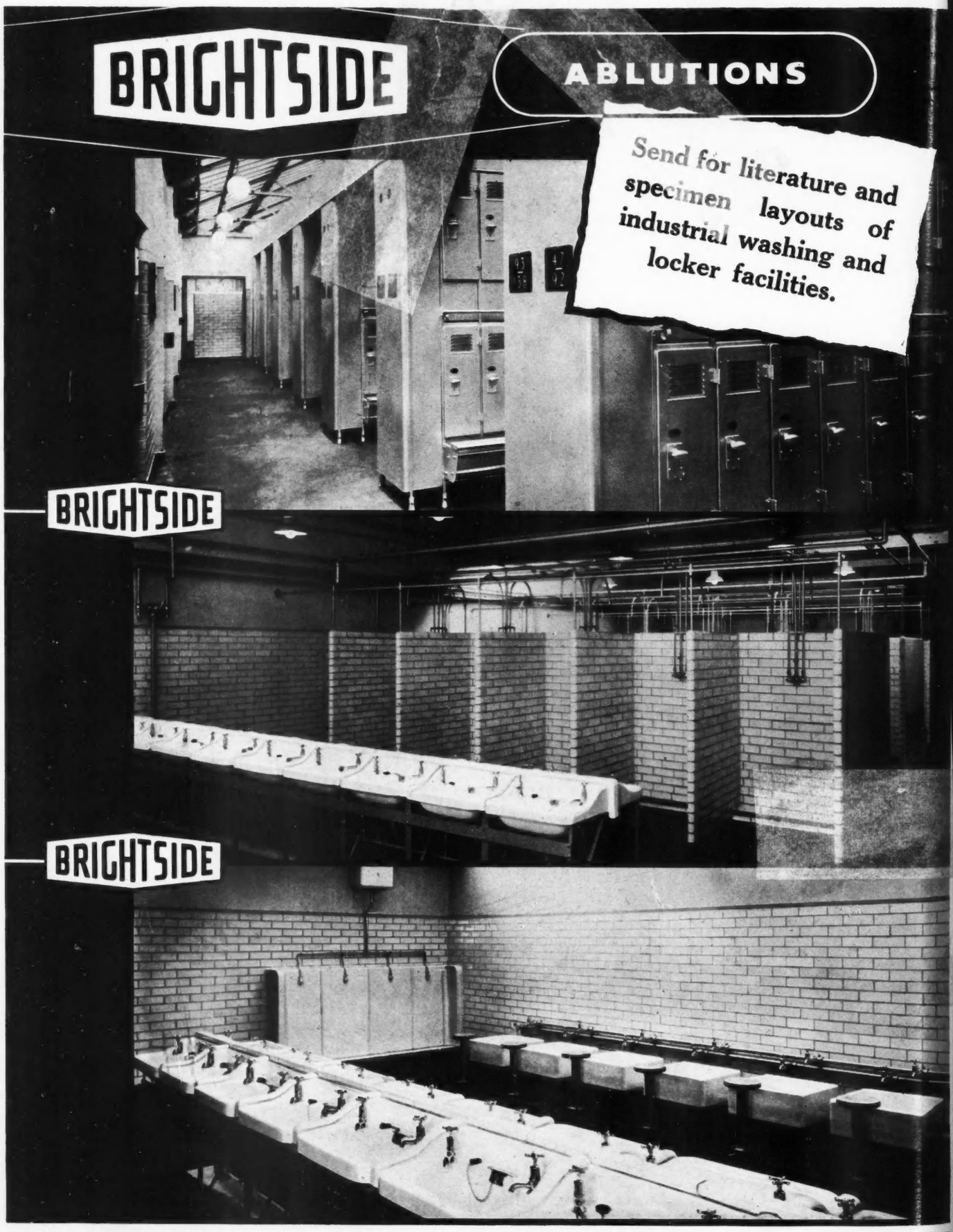
EDITED BY CHARLES COMBER AND J. FOSTER PETREE.

35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.2. TELEPHONE: TEMPLE BAR 3663.

VOL. 176—No. 4582 LONDON: FRIDAY, NOVEMBER 20, 1953. Price 2s.

UNIVERSITY OF MICHIGAN DEC 9 1953 ENGINEERING LIBRARY

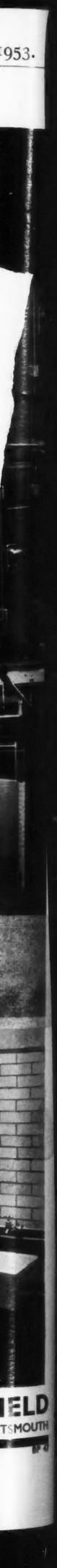
MARKING OUT FOR PATTERN MAKING.



THE BRIGHTSIDE FOUNDRY & ENGINEERING CO LTD SHEFFIELD

and at BELFAST · BIRMINGHAM · BRADFORD · BRISTOL · EDINBURGH · GLASGOW · LIVERPOOL · LONDON · MANCHESTER · NEWCASTLE · PORTSMOUTH

BF-4


953.
ELD
TSMOUTH

THE MINING MACHINERY OF THE ATLAS DIESEL COMPANY.

The principal material resources of Sweden are iron ore, timber and water power. The development of the third of these was dealt with in an article published in Engineering last year,* while the second, although it is an important factor in the nation's prosperity, presents only simple problems from the mechanical point of view. On the other hand, the mining of iron ore and its subsequent processing into steel of different grades have led to the design and manufacture of a great deal of interesting equipment; and this in turn has brought about a number of economic advantages. Some indication of the progress made in these directions is given in this article.

The main ore deposits of Sweden are to be found in the centre of the country, where the yield of the Bergslagen in 1951 was some 4 million tons with both high and low phosphorus contents. About one-quarter of this total yield was processed in Sweden, a proportion into high-quality steel, while the rest was exported. In Lapland, there are vast deposits of magnetic ores at Kiruna and Gällivare, which contain from 60 to 71 per cent. of iron and 1 to 2 per cent. of phosphorus. In 1951 the yield from these fields was about 12 million tons, almost all of which was exported without preliminary processing.

Two main methods of producing steel from these ores are employed, one of which, based on charcoal iron, concentrates on the manufacture of high-quality grades, both for home consumption and export, while the other, based partly on coke iron, but mostly upon scrap, is used for the production of structural steel, rails and wire rods. In 1951 the high-quality steels accounted for 27 per cent. of the total output by volume, but their manufacture has recently been threatened by a shortage of charcoal. The steel-makers are therefore expanding their facilities for the production of sponge iron, the output of which is expected to increase considerably from the present figure of 40,000 tons per annum when works now in course of erection are opened. For the production of steel, both open-hearth and electric-arc furnaces are used, each accounting for about 34 per cent. of the ingots manufactured, while 15 per cent., including the steels of special quality which are required for such purposes as ball-bearing manufacture, is made by the acid open-hearth process. High-speed tool steels and stainless steels are mainly smelted in induction furnaces.

High-quality tool metal has been made in Sweden for over 800 years and 200 years ago 40 per cent. of the world's iron output was produced in that country. Nevertheless, it was not until about the middle of last century, when the railway system was inaugurated, that development began on a really large scale. This development naturally led to the formation of manufacturing firms, among which was the Aktiebolaget Atlas, which was founded at Södertälje in 1873 for the production of all kinds of materials used in the building and operation of railways. As far as locomotives and carriages were concerned, this work was carried out in co-operation with the British firm of Beyer, Peacock and Company. In 1891 the Atlas factory was moved to Stockholm and the manufacture of machine tools, bridges and other structures was added to its original activities. This move corresponded with a period of trade depression, the result of which was that the company was reconstructed as the Nya Aktiebolaget Atlas. The setback was, however, temporary and two years later the production of caulking hammers was started, a step which may be said to mark the genesis of one of the present organisation's principal activities. Compressors of both Swedish and German design for supplying the necessary air for these tools were added to the range of manufactures in 1905, so that the firm was then able to provide equipment for one complete branch of iron-ore mining.

In the meantime, another interesting development had taken place in the shape of an agreement with Dr. Rudolf Diesel to manufacture his engines under licence, a company known as Aktiebolaget Diesel Motoren being formed for this purpose. The first of these engines was completed in 1899. Since then, more than 600 ships have been equipped and more than 7,200 stationary units with outputs ranging from 50 to 5,000 h.p. have been supplied. The two companies—Nya Aktiebolaget Atlas and Aktiebolaget Diesel Motoren—were amalgamated in 1917 as Aktiebolaget Atlas Diesel. In 1948, owing to the increasing production of air compressors of both the stationary and mobile types as well as of pneumatic tools of all kinds, it was found desirable to abandon the manufacture of Diesel engines, which was accordingly transferred to Nydqvist and Holm A/B., of Trollhättan. In addition, the widespread acceptance of the Swedish method of tunnelling, largely evolved by Atlas, meant that extra factory space was needed for the production of rock drills and auxiliary equipment. Other manufactures are fuel-injection pumps for Diesel engines and many types of air-operated rotary tools, such as drills and grinders, paint-spray guns and their accessories, pneumatic loaders, air hoists and winches.

These activities of Atlas Diesel are carried out in a number of factories, the largest of which is at Sickla on the outskirts of Stockholm. A view of the newer parts of this works, which now covers a floor area of 522,000 sq. ft. in addition to extensive office buildings, and where there is employment for some 2,300 workers, is given in Fig. 1. The main building accommodates a large shop consisting of four bays in which compressors are produced. Adjacent to this are the grinding department and automatic and semi-automatic lathe shops and separate beds for the assembly and testing of stationary and portable compressors. Other buildings are devoted to heat treatment and forging and pickling processes, and there are extensive stores for both raw materials and finished products. The production of rock drills and the carrying out of general turning, milling, drilling and tool-sharpening operations are conducted in shops above the grinding department, and experimental laboratory and research departments are accommodated in separate buildings. Fig. 2, Plate XXXIV, is a view of part of the shop in which stationary compressors are assembled, while Fig. 4, on the same Plate, is an illustration of the shop in which the portable compressors are built up and Fig. 11, on page 643, illustrates the grinding shop. Finally, mention may be made of a test mine, a corner of which is illustrated in Fig. 6, Plate XXXV, in which tests are made on drills—an operation which is facilitated by the rocky sub-soil of Stockholm.

A power supply for the works is obtained from the city of Stockholm electricity system and is transformed to 380 volts for power and 110 volts for lighting purposes in 23 transformers with a total capacity of 8,200 kVA. The aggregate horse-power of the 1,570 electric motors involved for driving the various machines is about 10,000 h.p. and the annual electrical consumption is rather over 13·2 million kilowatt-hours. Water for cooling and domestic purposes is drawn from Lake Langsjön by five electrically-driven pumps. Hot and warm water for heating is obtained from 19 boilers, which also supply low-pressure steam for process purposes.

Fig. 1. View of Part of the Sickla Works, Stockholm.

* See Engineering, vol. 174, page 585 (1952).

Typical products of the Sickla factory are heavy-duty air compressors, which have been specially designed for continuous operation in mines, engineering works and shipyards. A number of these machines in course of construction are shown in Fig. 3, Plate XXXIV, while their design may be made clear by describing one of the AR9 type, ten of which have been ordered by the National Coal Board. Two of these compressors are already in use at Mountain Colliery, near Swansea, while the others are either awaiting installation or dispatch. All but one of these machines are driven by a flywheel-type synchronous motor with an output of 540 h.p., the rotor of which is overhung from the compressor shaft and runs at 300 r.p.m. The output at a pressure of 100 lb. per square inch, which is higher than the standard of 80 lb. per square inch used in the South Wales Collieries, is 3,220 cub. ft. per minute. The general appearance of a finished machine will also be clear from Fig. 5, Plate XXXIV, although this illustration was actually taken at the Grängesberg iron-ore mine in Sweden where a number of similar sets are in use.

Air Compressors.

As regards construction, the crankcase of these compressors is cast in one piece with the cross-head guides. The alloy-steel crankshaft is a forging, which is machined all over and is fitted with two counterweights for balancing purposes. It is carried in self-aligning spherical-roller bearings. The connecting rods have detachable big-end bearings of cast steel with directly cast-in white-metal liners, the clearance being adjustable by shims. The small end of the connecting rod has a bronze bush for the gudgeon pin. This pin, which is made of case-hardened steel, has ground conical ends for fixing to the cross-head. The cross-head itself is a steel casting with detachable white-metal lined shoes. Both the gudgeon-pin bearings and the cross-head guides are forced-lubricated through oilways in the connecting rod. The cast-iron pistons are secured to the piston rods by a taper and screw fitting. The low-pressure piston has two and the high-pressure piston three rings. The alloy-steel piston rods are sealed by stuffing boxes, which are fitted with cast-iron rings. Below the stuffing boxes are scraper rings which remove the lubricating oil from the piston rods and prevent it entering the cylinders. The valves of both the outer and inner cylinder chambers are arranged in the cylinder body. They are of the ring type with several separate concentric plates, all the faces of which are ground to a high finish. The impact of the plates on the cast-steel valve guards is reduced by buffers. The valve guards contain recesses for the springs, which press the plates against the cast-iron seats.

The output of the compressor is controlled by automatic unloading valves which connect the cylinder chamber to clearance pockets in the wall. As a result, during the compression stroke part of the air is forced into a pocket instead of through the delivery valve. Each chamber has two pockets, which can be connected for either half or full loading. Unloading is therefore possible in four steps at full, three-quarter, half and one-quarter loads, respectively. The regulating valve is operated by compressed air and consists of a main plunger, which controls the supply of air to four auxiliary plungers. These, in turn, distribute the air to the unloading pistons. The regulating valve can be adjusted to provide a pressure difference of 3 lb. per square inch between the unloading steps, so that the total pressure difference between no load and full load is 11 lb. per square inch. This use of clearance pockets ensures high efficiency at partial loads, while a further advantage is that the stresses on the bearings and reciprocating points are balanced.

Safety devices are fitted, which operate if the lubricating oil pressure is too low, if the cooling water flow is insufficient or if its temperature becomes too high. Lubricating oil is circulated by a gear pump, which is directly coupled to one end of the crankshaft, a relief valve being provided to ensure that the system is maintained under pressure. The cylinders are lubricated by a forced-feed lubricator, which is driven from the shaft through worm gear. The cylinders and their heads are water-cooled. The intercooler consists of a cast-iron body, cooling tubes of corrosion-resisting alloy and cast bronze end plates and baffle plates. After assembly the exteriors of the tubes, with their end and baffle plates, are tinned so as to improve the heat transfer. These compressors can be driven through gearing by high-speed motors or by engines.

A number of the portable air compressors made by the firm are shown undergoing assembly in Fig. 4, Plate XXXIV, and in the painting shop at the Sickla works in Fig. 9, Plate XXXV. These machines may be taken as typical of the range of the firm's products in this class. Among them mention may be made of the two-cylinder V-type two-stage single-acting air-cooled machine, which is provided with an air-cooled finned tubular intercooler. The flywheel of this machine is of the fan type and draws cooling air along the crankcase through a volute casing and over the cylinders, cylinder head and intercooler. The crankshaft is of drop-forged flame-hardened steel and has one crank which carries the connecting rods. The high-pressure piston is of cast-iron and the low-pressure piston of light alloy, both being balanced to ensure vibration-free running. The suction and discharge valves are of the lightweight high-speed types and forced lubrication is supplied to all bearings from a geared pump. These compressors are often driven by a twin-cylinder air-cooled cold-starting direct-ignition Diesel engine, which develops 20 h.p. at 1,400 r.p.m. Regulation is effected by the air pressure, so that compression is automatically suspended when a pre-determined value, usually 100 lb. per square inch, is reached. The compressor then runs light until the pressure falls below this pre-set value, when compression is resumed. The air receiver is of the horizontal type. As will be seen from Fig. 9, Plate XXXV, these compressors are mounted on all-steel chassis, which are fitted with pneumatic-tyred wheels. They also have over-run and parking brakes. A box-type welded steel draw bar and retractable support legs are provided. The unit is covered with a pressed-steel canopy with detachable folding side shutters, which can be locked in the closed position. All the controls are completely enclosed when not in use. This type of compressor can deliver 63 cub. ft. of free air per minute at a maximum pressure of 100 lb. per square inch.

An interesting feature of the engine-driven compressors types FR4V and HR4V, which are among the other Atlas products, is the use of powder cartridges for starting. A cartridge is inserted in the cylinder head nearest the flywheel and exploded. The piston is thus depressed and the crankshaft begins to rotate. When the pistons in the other cylinders reach the top of their stroke self-ignition paper rolls, which have been placed in them, are set off by the heat developed during compression. Ignition then takes place and the engine runs up to speed in the usual way.

Rock Drills.

One of the most important products of the Sickla works of the Atlas concern are rock drills. These have been manufactured by the firm in one form or another for the past 50 years. About 10 years ago a considerable change in practice in this field took place when the company introduced light-weight rock drills for use with Coromant drill rods tipped with tungsten carbide. The light-weight rock drill and pneumatic pusher combination can easily be moved about, thus ensuring a high utilisation time and less expenditure of labour. Changes of drill rods are reduced by virtue of the long feed length of the pusher and the durability of the tungsten carbide gives a constant high rate of penetration. A hole can be started and completed with drill rods of much smaller diameter than when ordinary steel bits are used. The equipment used for this operation consists of a hollow drill rod of special alloy steel, which is heat treated to withstand the stresses to which it is exposed. A Sandvik tungsten-carbide insert is brazed to the rod and is shaped so that maximum drilling speed and durability are ensured, binding is eliminated and redressing reduced to a minimum. A hole is placed on one side of the bit stock so that flushing is improved and clogging of the hole with cuttings is prevented. The rock drills themselves are made in various sizes to cover all fields of service.

One feature of these rock drilling machines is that the main valve is of the rocker type. Lubrication is effected by incorporating an air line oiler in the system, which ensures complete lubrication of all parts. On some machines additional lubrication of the chuck is effected through a grease nipple situated in the lower part of the drill. Another unusual piece of equipment is the air blowing nozzle which can be fitted to the drill shanks and thus facilitates the removal of steels, that may have become jammed, by applying the full air pressure to the flushing hole. In places where it would be difficult to employ an ordinary pusher, i.e., where drilling of up-holes is involved, a raising feed is used. The thrust exerted by the pneumatic pusher and this raising feed can be finely regulated because the control handle incorporates a reducing valve. The feed pressure can be released immediately by a quick release if the drill steel strikes a fissure. A view of a typical stationary drilling assembly in the testing mine at Sickla is given in Fig. 6, Plate XXXV.

Fig. 7, Plate XXXV, illustrates one of the firm's latest wagon drills, which has been designed for use in the famous Kiruna mine in the north of Sweden. When exploitation of this mine was started on a large scale underground, the proprietors selected sub-level caving as the most suitable method of operation and wished to obtain a drill for this purpose which could drill holes arranged in the shape of a fan. The equipment designed by the Atlas company to comply with this condition consists of a carriage with four pneumatic-tyred wheels, the smaller pair of which is used for steering. This carriage supports a cast frame with an internal gear housing from which two shafts extend. These shafts carry cross members on which two pivoted feed beams are mounted and the beams themselves support the drill carriages which are driven by air motors in the frame. The feed beams can be moved more than 180 deg. horizontally and about 30 deg. from a straight vertical position. These operations are effected by separate air motors which drive the longitudinal shafts through gearing. The feed length of the present machine is about 8 ft.

During drilling the carriage is supported at four points by crank-operated jacks and the feeds are locked by a compressed-air brake which operates against two drums on the longitudinal shafts. This brake is released automatically when the feeds are moved, so that new holes can be drilled. The upper ends of the feeds are equipped with slides which act as supports for the beams. A tool holder for the drill steel is fixed to each device. Compressed air for operating the unit is obtained from an electrically-driven compressor, which is mounted on a separate pneumatic-tyred chassis. As it can be taken down the mine, the laying of expensive and awkward compressed-air lines is avoided, while a further advantage is that the hot compressed air reduces the mist and improves the working conditions.

At Kiruna this equipment is used for ring drilling in drifts 10 ft. high and 15 ft. wide, 16 holes with

THE MINING MACHINERY OF THE ATLAS DIESEL COMPANY, STOCKHOLM.

(*For Description, see Page* 641.)

(*To face page* 642.)

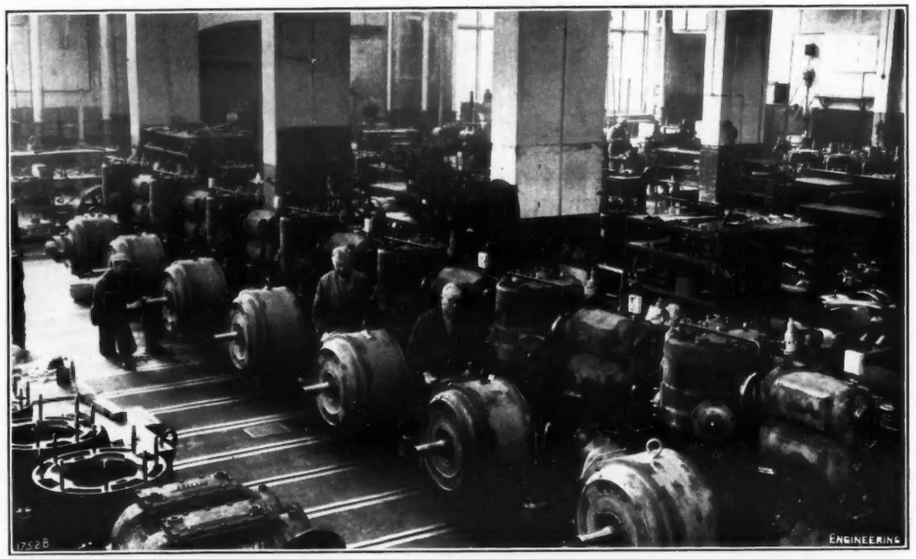


FIG. 2. ASSEMBLY SHOP FOR STATIONARY COMPRESSORS.

FIG. 3. STATIONARY COMPRESSORS UNDER CONSTRUCTION.

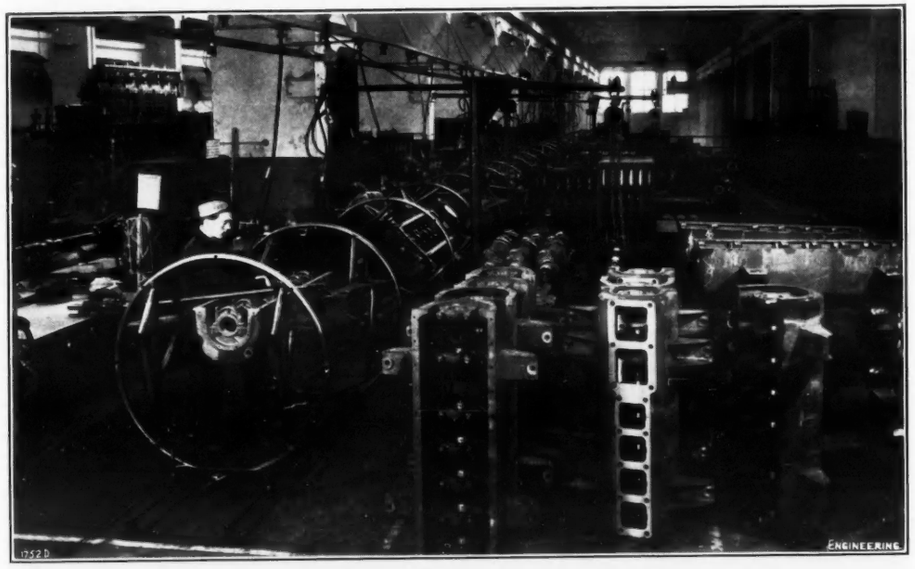


FIG. 4. PORTABLE-COMPRESSOR ASSEMBLY SHOP.

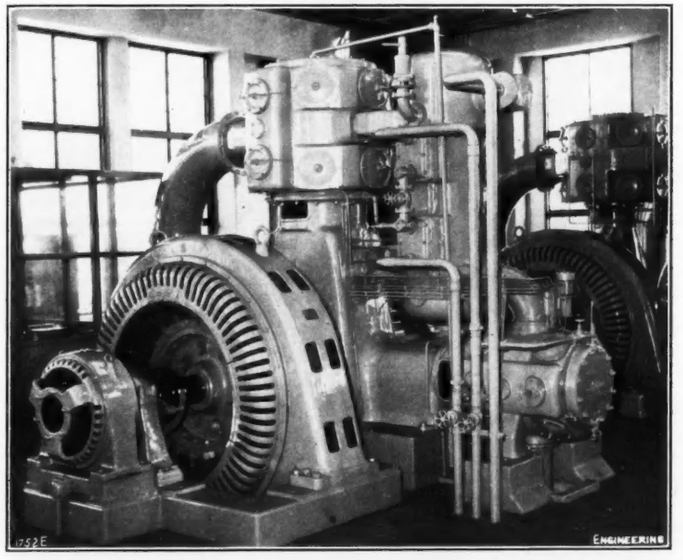


FIG. 5. HEAVY-DUTY MINING COMPRESSOR.

THE MINING MACHINERY OF THE ATLAS DIESEL COMPANY, STOCKHOLM.

(*For Description, see Page* 641.)

FIG. 6. ROCK DRILL IN TEST MINE.

FIG. 7. WAGON DRILL FOR KIRUNA IRON-ORE MINE.

FIG. 8. PNEUMATIC MINER'S LAMP.

FIG. 9. COMPLETED PORTABLE COMPRESSORS.

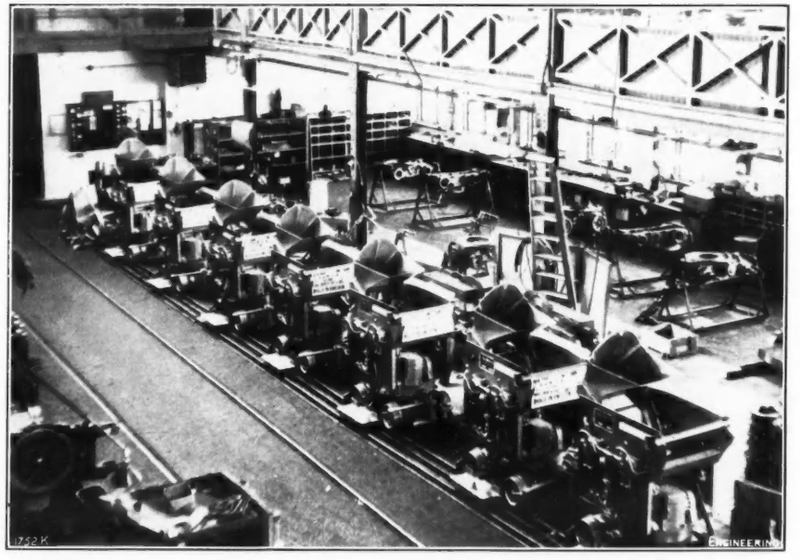


FIG. 10. ORE LOADERS IN AVOS WORKS.

(*To face page* 643.)

MINING MACHINERY OF ATLAS DIESEL COMPANY.

FIG. 11. GRINDING SHOP.

a maximum depth of 20 ft. being drilled in each ring and the distance between the rings being from 3 to 4 ft. When the top holes are being drilled the feeding equipment is arranged at an angle of 70 deg. to the horizontal plane. The equipment can be operated by one man from a table on which the necessary controls both for the drills and the feeding mechanism are installed. As much as 500 ft. of rock have been drilled in an eight-hour shift.

Among the other interesting developments in drilling technique with which the firm has been associated, mention may be made of the flexible tungsten-carbide drill steels with flat-bar steel rods. About two years ago, the company introduced a 12 mm. by 26 mm. steel of rectangular section made by the Sandvik Steel Company, Limited, and by utilising this in mines where sub-level caving is practised, the section of the sub-level can be reduced and the vertical displacement between sub-levels increased, thus achieving more economical operation. Holes of about 24 ft. can be drilled vertically from a sub-level having a headroom of only 7 to 8 ft. As in the case of the ordinary tungsten-carbide tipped drills, these drills have a central hole, but there is no collar. They are used in conjunction with a rock drill fitted with an anvil block and rectangular rotation chuck. They also enable thick slices to be cut in sub-level caving and shrinkage stoping.

A further development in the Atlas Diesel organisation was the incorporation of the Injector Company A/B. with the main concern in 1947. At that time the factory of the latter firm was used for the production of injectors for portable compressors, but in 1952 the manufacture of pneumatic tools was gradually transferred to these works and over 30 types are now in production. These include an air-operated circular saw with a 9-in. blade and a cutting depth of up to 3 in. The cutting angle of this tool can be adjusted to 45 deg. on each side of the normal position. Using a standard blade, the saw can be employed not only on wood, wall boards, asbestos and cement, but also on harder materials, such as light metal. Chippers, riveters, core removers, drills, tappers and screwdrivers and nut runners, all of which are air operated, are among the numerous other products of this factory. Mention may also be made of the 150-watt mining lamp, which is illustrated in Fig. 8, Plate XXXV. This consists of two compartments in one of which is a small air turbine and the rotor of a 12-volt generator of the six-pole permanent-magnet type. Both turbine and generator are mounted on the same shaft, which runs in ball bearings. The other compartment contains the lamp and is covered by a hardened front glass, which is secured by a cowl and screws pressing against rubber seals, as absolute air-tightness is essential. The reflector is also secured by the front glass. The turbine has been designed to operate at a pressure of 42 lb. per square inch, which is maintained constant by a reducing valve irrespective of any variations in the primary pressure. On its way to the turbine the air is passed through the bulb compartment, thus rendering the latter explosion-proof. On the inlet side of the reducing valve is a filter which protects the nozzles and turbine wheel from dust. The exhaust air leaves the turbine on the outside of the stator with the jet directed forward, thus providing the necessary cooling. As will be seen, the lamp is mounted in a yoke so that it can be turned in any direction.

MINE LOADERS.

The factory of A/B. Avos, which is another of Atlas Diesel's subsidiary companies, is situated in the town of Örebro and was originally used for the production of mechanical tools, saws and signalling equipment. It is now employed for the manufacture of three different types of mine loaders, but later on pneumatic hoists, winches and compressed air motors are to be made there. When that happens all Atlas transport equipment will be produced under one roof. The factory area at present covers about 40,000 sq. m. and includes the office building, the main engineering shop and a foundry. A view in the main shop at this works, showing a range of typical loaders, appears in Fig. 10, Plate XXXV.

The two smaller loaders, which differ only in a slight variation of physical dimensions, have a bucket capacity of 3·9 cub. ft. They are designed for operation by compressed air at pressures between 80 and 115 lb. per square inch, but can also be driven by low-pressure motors supplied at between 60 and 80 lb. per square inch. The four-wheeled bogie, on which the machine is mounted, is fitted with a buffer. The bucket and cradle are mounted on a swivelling frame and are carried on a double ball race. Ball bearings are employed throughout the machine to the greatest possible extent. It is possible to interchange motors on the job in a very short time, thus reducing breakdown delays to a minimum. The buckets have been designed after extensive tests in a number of mines and are shaped so that digging in heavily packed material and the loading of large blocks are possible. As the loaders are exposed to the heaviest stresses when driven forward against the pile with the bucket in its bottom position, the bogie is fitted with a buffer and the frame carries a special shaft, which relieves any strain on the dumping chain and fastening cables of the cradle. Moreover, during the initial upward digging movement of the bucket the cradle rests on the shaft thereby saving the cables. The drum carrying the chain, through which the operating motor drives, has a slot in which the chain of the digging unit is secured. If by mistake the bucket-operating motor is run in the wrong direction when the bucket is in its bottom position the chain is automatically disengaged, so that its breakdown or that of the bearing is prevented.

Loaders of similar design, but with a bucket capacity of 7 cub. ft., are now in use by the National Coal Board. These machines have a height of 8·3 ft. above the track and a digging width of 9 ft. The upper part is mounted on double ball bearings which are secured to the bogie by bolts and carry three rings so that while they can rotate they cannot become stuck. They are designed so that the centre bolt need not pivot, but can be tightened up. When in the digging position, the cradle is supported by two pins in the swivelling frame, so that good leverage is obtained between the power in the operating chain and the load in the bucket. In the discharging position the arms of the buckets make contact with a bumper, which consists of a bar extending transversely across the machine. The movement of this bar is checked by helical springs which are contained in tubes to prevent eccentric loading.

The air motor operating the bucket is of the six-cylinder type with an output of 14 h.p., while a five-cylinder motor of similar design and output of 11 h.p. is used for traction. The cylinder diameter and stroke are the same in both cases. The drive is through gearing, and silencers are fitted to ensure noiseless operation. The motor driving the bucket is controlled by a lever through a dual valve, so that the machine can be moved laterally in both directions. A second lever is provided for the traction motor. This controls a stop piston so that the swing is interrupted when the frame is in its central position. When the machine has to be moved in either direction, air is shut off from this stop piston, which is pulled down by a spring so that the machine is free to move laterally.

Finally, mention may be made of a shuttle car and conveyor which has been designed by the Atlas Diesel Company in association with the Grängesberg Company and is being tested in the mine of the latter concern. It consists of a vane motor which enables a speed of some 250 ft. per minute to be obtained. This motor is supplied with air through a 1-in. hose, 330 ft. of which can be reeled up on a roller, which is driven by a separate motor. The conveyor runs at a speed of 33 ft. per minute, so that an 88 cub. ft. car can be fully loaded in about 45 seconds.

DIESEL-ENGINED MOTOR CAR.—The Standard Motor Company, Ltd., Coventry, have announced that they will, in a very short time, start the production of a Diesel-engined motor car. A prototype vehicle has already undergone extensive tests on the Continent, and is said to have shown remarkable economies in the consumption of fuel.

LITERATURE.

Luminescence and the Scintillation Counter.

By Dr. S. C. Curran, F.R.S. Butterworths Scientific Publications, 88, Kingsway, London, W.C.2. [Price 32*s.* 6*d.*]

The light flashes emitted when a zinc-sulphide screen is bombarded with α-particles were made familiar many years ago in the Crookes "spinthariscope" and the visual counting of these scintillations was developed into a powerful tool by the late Lord Rutherford in his fundamental studies in radioactivity and artificial transmutation. The virtual abandonment of this tedious subjective method was brought about by improvements in the Geiger-Müller and other types of counter, and it was only in 1944 that the first modern type of scintillation counter was introduced by Dr. Curran. In this the eye is replaced by a photo-multiplier capable of delivering large pulses of current of short duration, one per scintillation, that can be registered directly by an appropriate electronic device. This new instrument is flexible and robust, it is responsive to both particles and quanta and its signal to noise ratio is high; it can count at rates exceeding those possible with any other counting device and it has already played a major part in atomic and nuclear research.

After a brief preliminary outline of the main components included in the scintillation detector and of the physical principles involved in its operation, an account is given of the various known types of radiation and the manner in which they interact with matter. Then follow three chapters dealing, firstly, with such aspects of secondary emission as are utilised in the design and operation of a multiplier tube, secondly, with the structural features of electron and photo-multipliers and, thirdly, with the characteristics and performance data of American and British commercial tubes. The next four chapters contain a survey of the luminescence of solids, the fluorescence of organic solids and liquids, the preparation of scintillating crystals and liquids, and the properties of specific crystals and liquids. Much of the work described is recent, having been stimulated by the search for more efficient luminescent materials for use in conjunction with the scintillation counter. It is found, for instance, that although it is normally necessary to incorporate an activator in inorganic crystals, organic crystals are required to be of the highest purity and freedom from imperfections. Moreover, though both types of crystal show comparable conversion efficiencies for electrons, organic crystals respond poorly to heavy ionising radiations such as α-particles and protons. Useful information is also provided concerning decay times, which, with liquid scintillators, may be as low as 3 to 5×10^{-9} second, which make them specially valuable for high-speed counting and coincidence work. Other promising developments are the use of lithium iodide (with thallium or tin as activator) for work with slow neutrons, and the introduction of plastic scintillators. Applications of scintillation counters and multiplier tubes form the subject of the next two chapters. The outstanding advantages of the scintillation counter for detection and as an aid in the spectrometry of radiations are described, with emphasis on the more basic problems of gamma, neutron and meson spectroscopy, together with the benefits of using multipliers to overcome difficulties in the operation of scintillation counters *in vacuo* for work on the decay of neutrons and as recorders in mass spectroscopy. The final chapter discusses some of the ingenious circuits that have been devised to operate in conjunction with scintillation counters, including fast scaling and pulse-shaping circuits, amplifier and display systems, discriminator and pulse amplitude analysis circuits.

The scintillation method in its original form rendered inestimable service in the pioneer investigations of nuclear radiations: in its revised form it has already taken pride of place among electrical methods of counting and analysis and it is full of promise for the future. In this book Dr. Curran has provided a compact and comprehensive guide covering all aspects of the present theory and current practice of the modern scintillation counter.

Circuit Breaking. Researches by the British Electrical and Allied Industries Research Association.

Edited by H. Trencham, M.I.C.E., M.I.E.E. Butterworths Scientific Publications, 88, Kingsway, London, W.C.2. [Price 30*s.* net.]

Oil has been employed to extinguish the arc produced when an electric circuit is broken for some 50 years or more. Early circuit-breakers consisted of fixed and moving contacts mounted in an oil tank, and it was supposed that when the circuit was broken the oil flowed into the arc gap and quenched the arc. This simple explanation was generally accepted when the Electrical Research Association started circuit-breaker research in 1920. It is now known that when the contacts separate the arc is formed in a highly-ionised gap which is conducting. At current zeros, further ionisation ceases and the practical problem presented is to introduce an insulating medium between the contacts during this brief period. The vaporised oil produces a gas bubble, mainly of hydrogen, which is under pressure and serves to impel the arc into the narrow slots that are the essential feature of the various arc-control pots that have been introduced. The arc is swept clear by the rapidly-moving jet of oil induced by the gas pressure.

The oil in a circuit-breaker is an effective insulator; but so is air, and as the primary purpose of the oil is to generate gas under pressure, it was realised that the use of air under pressure might have advantages. This idea has resulted in the introduction of the various forms of air-blast circuit-breaker which are a feature of modern practice, especially in connection with the higher voltages. As is well known, air-blast breakers appeared in a commercial form and were used on the Continent some years before they were developed by British manufacturers. This may have been partly due to customer-resistance or works programmes. A point of interest brought out in this book, however, is that the Electrical Research Association, as a result of its investigations, filed the first main air-blast circuit-breaker patent. This was of a basic character and many Continental breakers should, and had it not been for the war probably would, have been made under licence from the Association. Licensing arrangements have now been entered into with builders both in Germany and America.

This elementary and incomplete dissertation on circuit-breaker design must not be taken as a complete résumé of the contents of the book. It illustrates, however, the influence on practice of the work of the Association. Other cases might be mentioned as, for instance, the side-vented explosion chamber which was patented and on which royalties were paid until the patent expired some years ago. The book is a reprint of a series of six lectures delivered in 1952 at the Polytechnic, Regent-street, London, and later repeated at Armstrong College, Newcastle-upon-Tyne. The authors, other than the editor of the volume, who delivered the last lecture, were members of the staff of the Association. They revealed every aspect, theoretical and practical, of the work carried out over some thirty years. In the last lecture Mr. Trencham, who has been so prominently associated with commercial practice, reviewed the impact of the work of the Association on circuit-breaker design. The volume constitutes a valuable treatise which should be in the hands not only of circuit-breaker designers but also of power-station and system operators. Advanced students will also profit from the clearly established theoretical background to some of the practical problems which may confront them in later years.

Introduction to the Foundations of Mathematics.

By Professor Raymond L. Wilder. John Wiley and Sons, Incorporated, 440 Fourth-avenue, New York 16, U.S.A. [Price 5·75 dols.); and Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 46*s.* net.]

As this book has been developed from the author's lectures to actuarial and other students in the University of Michigan, it differs in important particulars from other available text-books on the subject. In general plan, the work falls into two main parts. Part I starts with an exposition of the axiomatic method as it is commonly employed in modern mathematics, and proceeds, in the next three chapters, to the basic notions of the theory of sets which has been previously introduced in the use of axioms. The study of these topics brings much within easy reach of the man who has comparatively limited time to spare, for Chapters VI and VII explain how the axiomatic method is applied to the fundamental ideas of algebra, geometry, and analysis. Thus the discussion goes far to provide him with an insight into the conventional character of much which he has hitherto taken for granted, together with a clearer understanding of the intrinsic nature of the underlying concepts, as, for example, the infinite, the real number continuum, arithmetic, and geometry.

The arrangement of the work enables Professor Wilder, in Part II, to inquire more closely into the origin, meaning and validity of the previous considerations. For the class of student likely to read the book, the inclusion of numerous notes on the historical side of the subject will undoubtedly add interest to the formal treatment, especially in Chapter VIII, on the efforts by various individual mathematicians and "schools" to construct a sound basis for the subjects of their study, starting with the beginnings of analysis in the Eighteenth Century. These efforts soon led to remarkable achievements, since in the latter half of the Nineteenth Century mathematics had attained a state in which it was possible to do for the whole what Euclid had tried to do for geometry, by disclosing the underlying axioms or "primitive propositions" of Peano. The most patient investigation in this direction, first of the subject-matter itself and next of the very ideas that govern the subject-matter, is discussed in the next chapter, under the heading "The Frege-Russell Thesis: Mathematics an Extension of Logic." This chapter is most informative, as are also those on the other principal schools of thought, namely "Intuitionism" and "Formalism." While the book is naturally written for those who use mathematics as a study in itself or as an indispensable tool for statistical purposes, many engineers with a bias towards the history of science will find much of interest to them in the final chapter, which is devoted to the cultural setting of mathematics. There is a largeness about mathematics that transcends race and time; it has the utility of a language that is understood by all. The mere application of one of the simplest parts of the exquisitely original methods of Fourier to the conduction of electricity has made the name of Ohm famous wherever the language of engineers is spoken.

Commercial and Industrial Information Service.—The Islington Public Libraries have issued a leaflet describing the commercial and industrial information service available at Islington reference library, 68, Holloway-road, London, N.7. Inquiries may be made in person, in writing, or by telephone to NORth 4038. By arrangement with the Board of Trade, the Library is supplied with daily information on markets and details of export and import trade.

DIFFUSION OF LOAD INTO THE DECKS OF PLATE-GIRDER BRIDGES.

By A. H. Chilver, B.Sc., Ph.D.

The complex problem of stress diffusion in bridge-deck systems is one which has not received close study in the past. Some attempts have been made to discuss particular aspects of the subject, but at present a general treatment of the problem in simple terms is not available. The problem arises by virtue of the fact that a bridge deck, which may be a heavy structure attached more or less rigidly to the booms or web members of a bridge, itself possesses some extensional or compressional stiffness. For this reason a heavy deck may contribute appreciably to the total strength and stiffness of a bridge. The diffusion of load into the deck of a bridge gives rise to two further problems: firstly, the booms of the bridge may be somewhat relieved of stress; and, secondly, stresses may be induced in the component members of the deck itself. Any theory of stress diffusion in bridge-deck systems must deal adequately with these aspects of the problem. Much, of course, depends upon the nature of the bridge and its deck system; it is common design practice to estimate the strength and stiffness of a bridge on the properties of the main frames or girders only. An analysis of the whole bridge structure, treated as a space frame, must depend entirely upon a complete understanding of the stress-diffusion problem. With a knowledge of load diffusion it may become possible to design a bridge so that due allowance is made for the contribution of the deck system to the total strength and stiffness. An understanding of the problem moreover makes possible an estimate of the extent to which an existing bridge may be loaded beyond its nominal maximum permissible load, without exceeding the allowable stresses in the booms or flanges.

The particular problem treated in this article is that of the diffusion of load into the decks of a uniformly-loaded plate-girder bridge. Two common types of deck construction are considered: in the first type the deck consists of longitudinal stringers which are interconnected by a single deck plate, while in the second type the longitudinal stringers are interconnected by heavy transverse girders. Simple diffusion theories are developed for decks consisting of a number of component members; these theories are such that individual treatment of the component members of the deck is unnecessary. On applying these theories it is possible to estimate the relevant internal actions throughout the decks and booms of the bridge. It is possible also to find the extent to which the main booms or flanges of the bridge are relieved of direct stress.

A plate-girder bridge is designed primarily to withstand concentrated and distributed vertical loads. A simple approach to the design of these bridges consists in assuming that the web plates resist all the vertical forces, while the booms resist the applied bending moments. These assumptions may not define completely the internal actions in the bridge; but because the contribution of the web plate to the total moment of resistance is small in comparison with that of the booms, the adoption of such a set of assumptions is not likely to give hypothetical internal load distributions which differ appreciably from those found in practice. On making these assumptions the relations between the shearing actions in the web of the plate girder and the longitudinal forces on the booms and decks are easily deduced. The span of the bridge is 2L, and h is the depth of the web of the plate girder (Fig. 1); each web plate withstands a vertical load of uniform linear intensity w. If this vertical load is not applied directly to the web plates, then it may be transmitted to the web plates through transverse girders placed at regular intervals along the length of the bridge. An elemental length of the web plate is acted upon by shearing forces only; equilibrium of this element is ensured if the actions between the element and the adjacent upper and lower boom elements are equal in magnitude and opposite in direction. The actions between the web plate and the booms are then independent of the relative values of the boom areas. If the uniform loading, w, is represented in terms of a Fourier series, then the linear intensity of the action between the web plate and the booms is given by

$$q = \sum_{n=1}^{\infty} \frac{-8\,w\,L\,(-1)^n}{(2\,n-1)^2\,\pi^2\,h} \sin(2\,n-1)\frac{\pi\,x}{2\,L}. \quad (1)$$

The internal actions in the web plates of the bridge are of no further concern; interest now lies in the diffusion of the forces, given by q, into the booms and decks of the bridge. If there is no buckling of the components of the compression deck, the diffusion problems for both the upper and lower decks may be treated similarly. The loading actions on the tension booms and deck are taken as typical and considered more closely; each tension boom of the bridge is subjected to longitudinal forces of linear intensity q. If there is no inter-

Fig. 1.

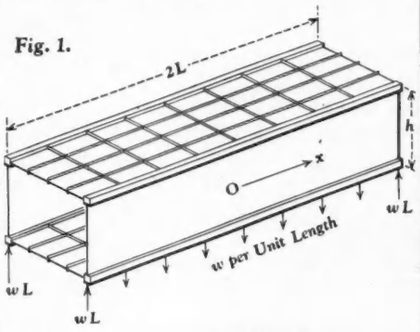
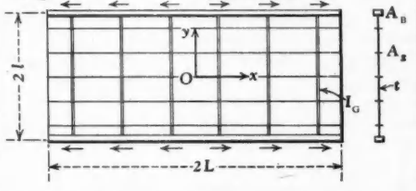


Fig. 2.



vening deck between the two booms, each boom withstands the full intensity of the forces q; in this case there is no diffusion problem. However, when the deck between the two tension booms has both tensional and shear stiffness, the proportion of load diffused into the deck depends upon the nature and form of construction of the deck itself. At this stage two forms of deck construction are envisaged: in the first form the booms are connected by a thin plate which is reinforced with longitudinal stringers; in the second form the booms are connected by heavy transverse girders which are themselves interconnected by longitudinal stringers. In the analytical work which follows, the basic concept of Williams* has been used to study diffusion effects in "plate-stringer" decks, while a new, and equally simple, technique is developed to study the diffusion of load in the "girder-stringer" type of deck. Throughout the discussion it is assumed that there are so many longitudinal stringers and transverse girders that individual treatment of each component of the deck is impracticable.

The first problem considered is one in which the the tension deck of the bridge consists of a thin deck plate reinforced with longitudinal stringers. The width of the deck is $2l$ (Fig. 2), the thickness of the deck plate is t, and the area of each longitudinal stringer is A_s; there are N_s stringers per unit width of the deck, while the distribution of stringers across the width is quite uniform. The booms, deck plate and stringers are all of the same material of elastic modulus E and shear modulus G. If the deck plate is of negligible tension stiffness and the stringers of negligible shear stiffness, then the state of stress at any point (x, y) of the deck may be defined by σ, the tension stress in the stringers, and τ, the shear stress in the deck plate. Furthermore, if u is the longitudinal displacement of a point (x, y) of the deck parallel to the axis Ox,

$$\sigma = E\frac{\partial u}{\partial x} \quad \text{and} \quad \tau = G\frac{\partial u}{\partial y}. \quad (2)$$

There is a small transverse displacement which is assumed to have a negligible effect on the shear distortion of the deck-plate. The condition of equilibrium of longitudinal forces on a composite rectangular element of the deck then gives

$$E\,A_s\,N_s\frac{\partial^2 u}{\partial x^2} + G\,t\frac{\partial^2 u}{\partial y^2} = 0. \quad (3)$$

A further condition of equilibrium, corresponding to forces on a composite element in the transverse direction, shows that a small transverse direct stress σ' exists; this stress will usually be supplied by weak transverse ribs. The effect of this transverse stress on the deck behaviour is assumed to be small and negligible. The solution of the differential equation (3) is made easier by taking the longitudinal displacement in the form

$$u = \sum_{n=1}^{\infty} F_{2n-1} \sin(2\,n-1)\frac{\pi\,x}{2\,L}, \quad (4)$$

in which F_{2n-1} is a function of y only; this expression satisfies the conditions that there is no longitudinal displacement at the centre of the deck, given by $x = 0$, and that there is no direct stress in the stringers at the extreme ends of the deck, given by $x = \pm L$. On substituting this value of u into equation (3), a set of total differential equations is derived from which the values of F_{2n-1} in equation (4) may be deduced directly. Each function F_{2n-1} then contains two arbitrary constants, which are eliminated by considering the conditions that the displaced form of the deck is symmetrical about the longitudinal axis Ox, and that there is equilibrium of forces at the junctions of the deck-plate and the booms. On taking into account these necessary conditions, the value of F_{2n-1} becomes

$$F_{2n-1} = \frac{32\,w\,L^3}{\pi^3\,E\,A_B\,h} \times \left[\frac{-(-1)^n}{(2\,n-1)^4}\,\frac{ch\,\alpha\,y}{ch\,\alpha\,l\left(1+\dfrac{A_s\,N_s\,l}{A_B}\,\dfrac{t\,h\,\alpha\,l}{\alpha\,l}\right)}\right]_{2n-1} \quad (5)$$

in which A_B is the area of each boom, taken as uniform throughout its length, and

$$(\alpha\,l)_{2n-1} = (2\,n-1)\frac{\pi}{2}\sqrt{\left(\frac{A_s\,N_s\,l}{A_B}\right)\left(\frac{E\,A_B\,l}{G\,t\,L^2}\right)}. \quad (6)$$

The second problem discussed is that in which the tension deck consists of heavy transverse girders connected by a set of longitudinal stringers. The stringers, each of cross-sectional area A_s, are again distributed uniformly across the width of the deck, at an intensity N_s per unit width. The transverse girders, each of relevant stiffness $E\,I_G$, are distributed uniformly along the length of the deck at an intensity N_G per unit length. The tension stress in the longitudinal stringers at any point (x, y) is again taken as σ, while the actions on a single transverse girder are given by a bending moment M and a shearing force S. Unlike the previous problem, in which a small transverse direct stress σ' is introduced to complete the equilibrium of an element of the deck, in the present case σ, M and S define completely all the actions at any point of the deck. If u is again the longitudinal

* D. Williams, R. D. Starkey and R. H. Taylor, *Aero. Res. Com. R. & M.* 2098 (1939).

LOADS ON DECKS OF PLATE-GIRDER BRIDGES.

Fig. 3.

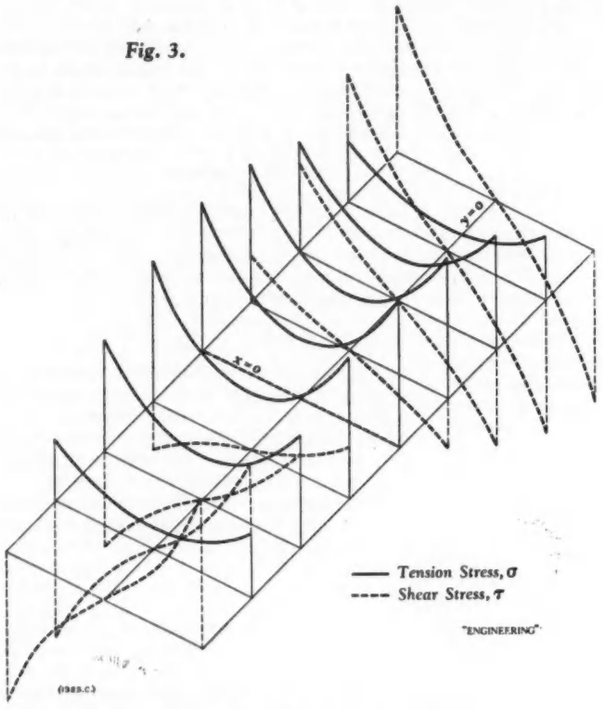


Fig. 4.

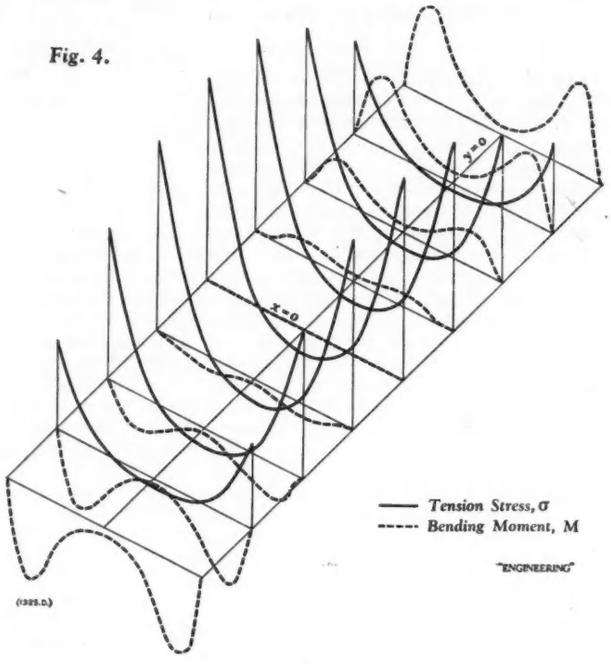
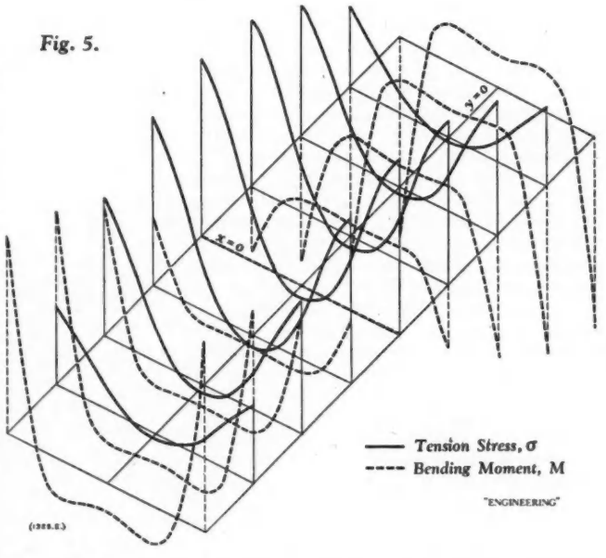


Fig. 5.



displacement of a point (x, y) of the deck parallel to the axis Ox, then

$$\sigma = E\frac{\partial u}{\partial x}, \quad M = E I_G \frac{\partial^2 u}{\partial y^2}, \text{ and } S = E I_G \frac{\partial^3 u}{\partial y^3}. \quad (7)$$

Then the equilibrium condition for any rectangular element of the composite deck may be written

$$A_s N_s \frac{\partial^2 u}{\partial x^2} - I_G N_G \frac{\partial^4 u}{\partial y^4} = 0. \quad . \quad (8)$$

The solution for the longitudinal displacement u is again taken in the form of the Fourier series of equation (4). Equation (8) then assumes the form of a set of fourth-order total differential equations from which the values of F_{2n-1} are derived directly. As before, these functions F_{2n-1} contain arbitrary constants which are eliminated by considering the conditions that the displaced form of the deck is again symmetrical about the longitudinal axis Ox, that there is equilibrium of forces at the junctions of the booms and transverse girders, and that the transverse girders are either pinned to or built into the adjacent booms. On taking into account these necessary conditions, the value of F_{2n-1} becomes, in this case,

$$F_{2n-1} = \frac{32w L^3}{\pi^3 E A_B h} \times \left[\frac{-(-1)^n}{(2n-1)^4} \cdot \frac{G(y)}{1 + \dfrac{A_s N_s l}{A_B}\theta_{2n-1}}\right]_{2n-1}, \quad (9)$$

in which

$$G(y)_{2n-1} = \left[\frac{ch\beta y \cos\beta y + \gamma sh\beta y \sin\beta y}{ch\beta l \cos\beta l + \gamma sh\beta l \sin\beta l}\right]_{2n-1}, \quad . \quad . \quad . \quad (10)$$

$$\theta_{2n-1} = \left[\frac{(1+\gamma)ch\beta l \sin\beta l + (1-\gamma)sh\beta l \cos\beta l}{2\beta l(ch\beta l \cos\beta l + \gamma sh\beta l \sin\beta l)}\right]_{2n-1}, \quad . \quad . \quad . \quad (11)$$

and

$$(\beta l)^2_{2n-1} = (2n-1)\frac{\pi}{4}\sqrt{\left(\frac{A_s N_s l}{A_B}\right)\left(\frac{A_B l^3}{I_G N_G L^2}\right)} \quad . \quad . \quad . \quad (12)$$

The value of γ_{2n-1} in these expressions depends upon whether the transverse girders are pinned to or built into the adjacent booms; in both cases, γ_{2n-1} is a trigonometric and hyperbolic function of $(\beta l)_{2n-1}$.

The internal actions in the deck of the bridge which are of most interest are the tension stresses in the longitudinal stringers, the shear stresses in the deck plate and the bending moments in the transverse girders. These several actions, given by σ, τ and M, respectively, are derived from the displaced form of the deck, which has been found for two forms of deck construction. For the former type of construction, consisting of a thin deck plate reinforced with longitudinal stringers, the distribution of σ and τ throughout the deck depends largely upon the relative values of the parameters $\left[\frac{A_s N_s l}{A_B}\right]$ and $\left[\frac{E A_B l}{G t L^2}\right]$; the first of these parameters is essentially a "stringer" parameter, defining the relative areas of stringers and booms, while the second is essentially a "plate" parameter. For the particular case in which both these parameters are equal to 1, the stress distributions take the forms shown in Fig. 3. For the case in which the deck is composed of transverse girders interconnected by longitudinal stringers, the distributions of tension stresses in the stringers and bending moments in the transverse girders become important. In this case the parameters which control the rate of load diffusion into the deck are $\left[\frac{A_s N_s l}{A_B}\right]$ and $\left[\frac{A_B l^3}{I_G N_G L^2}\right]$; the former is again the "stringer" parameter, while the latter is a "girder" parameter. When the first of these parameters is taken equal to 1, and the second equal to 100, the resulting stress and moment distributions take the forms shown in Figs. 4 and 5, for the two cases in which the transverse girders are pinned to and built into the adjacent boom members. It is interesting to note that where heavy transverse girders are present in the deck, it is possible that some of the longitudinal stringers near the centre of the tension deck may, in fact, be compressed. When the transverse girders are pinned to the booms, the most heavily stressed regions of the girders occur at points close to the booms, and not at the centres of the girders. When the transverse girders are built into the booms, the moments attain maximum values at the junctions of the girders and the booms; for each transverse girder there are two points of contraflexure.

An aspect of the problem which is of considerable interest is the extent to which the booms of the bridge are relieved of direct stress by the action of

LOADS ON DECKS OF PLATE-GIRDER BRIDGES.

Fig. 6. STRESS RELIEF, "PLATE-STRINGER" DECK.

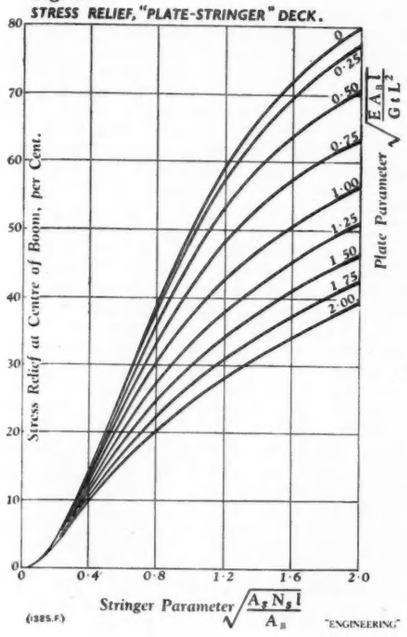


Fig. 7. STRESS RELIEF, "GIRDER-STRINGER" DECK (PINNED GIRDERS).

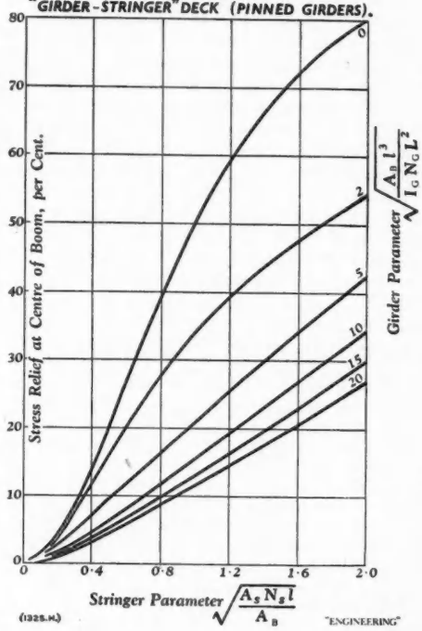


Fig. 8. STRESS RELIEF, "GIRDER-STRINGER" DECK (BUILT-IN GIRDERS).

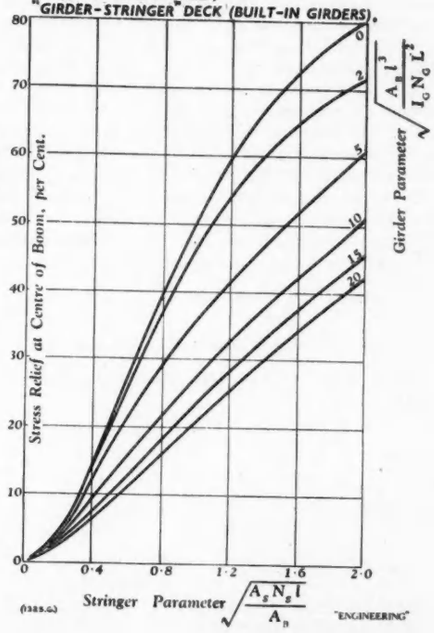
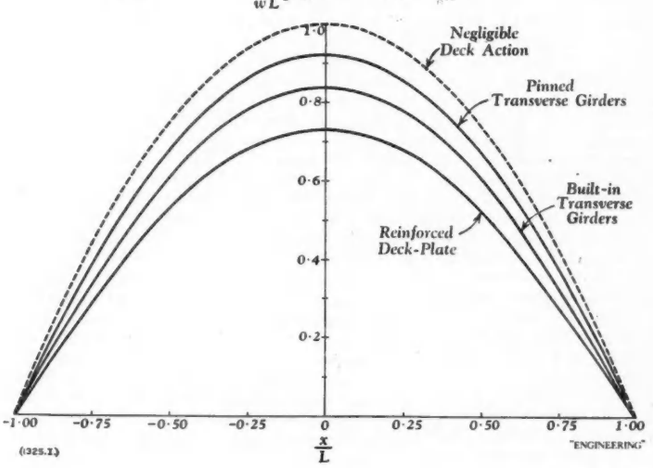


Fig. 9. $\frac{2\sigma_0 h}{wL^2}$ [Boom Area]



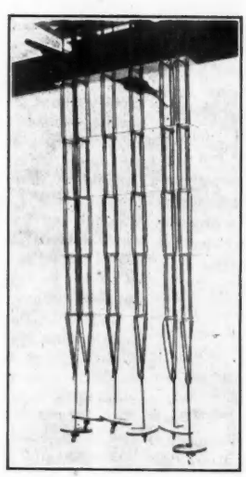


FIG. 10. MODEL WITH UNIFORM LOADS.

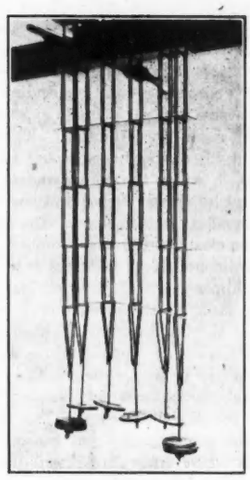
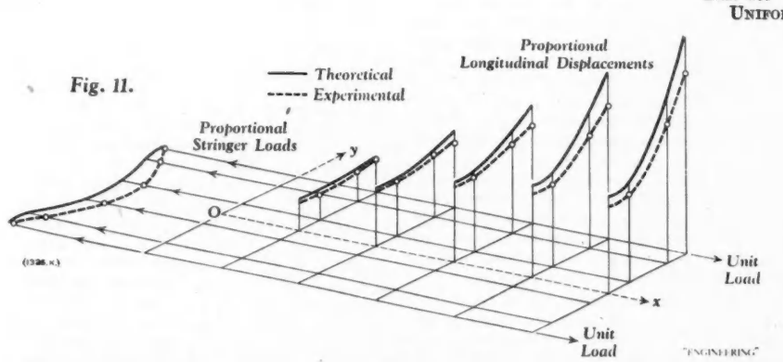


FIG. 12. MODEL WITH ADDITIONAL END LOADS.

Fig. 11.



the deck. A measure of this relief may be made by comparing the actual stresses in the booms with the stresses which would be present if the action of the deck were disregarded. In the absence of resistance from the deck, the tension and compression booms alone react the whole of the applied bending forces on the bridge; under these conditions, suppose that σ_{Bo} is the longitudinal stress in the boom at any section. If σ_B is the longitudinal stress in the boom taking into account diffusion of load into the deck, then the stress relief due to load diffusion is defined as $\frac{\sigma_{Bo} - \sigma_B}{\sigma_{Bo}}$, which may be expressed either fractionally or as a percentage value. For the "plate-stringer" type of construction, the stress relief at the centre of the boom, the most heavily stressed region, is found to depend again upon the "stringer" and "plate" parameters. Calculated values of stress relief are given in Fig. 6 for a wide range of values of the two parameters. When the deck consists of transverse girders and stringers, the degree of stress relief in the booms at mid-span in this case depends upon the "stringer" and "girder" parameters. Values of stress relief for the two cases when the transverse girders are pinned to and built into the booms are shown in Figs. 7 and 8 for a wide range of values of the two relevant parameters.

A common feature in plate-girder design is to "curtail" or reduce the flanges or booms of the girder near the supported ends of the bridge. This is permissible because the applied bending moments in these regions are relatively small. It is interesting to discuss the extent to which the boom areas may be further reduced to take account of load diffusion into the decks. Ideally, it is desirable

to arrange the cross-sectional area of the boom at any section so that the boom is uniformly stressed throughout its length. This implies a boom of variable cross-sectional area, and introduces at the same time a special type of boundary condition at the junction of the deck and the booms. If the uniform tension stress in the booms of the tension deck is σ_o, the nature of the longitudinal stress distribution throughout the deck is implicitly defined. In this way, the variation of boom area, for the uniformly-stressed condition, may be found. If the booms and all the stringers at the mid-span of the bridge could be fully stressed to σ_o, the total area of booms and stringers required at mid-span is calculable and given by, say, A_o. The variation of boom area is then largely dependent upon the values of $\frac{A_s N_s l}{A_o}$ and the parameters $\frac{E A_s N_s l^2}{G t L^2}$, for the "plate-stringer" type of deck, and $\frac{A_s N_s l^4}{I_G N_G L^2}$, for the "girder-stringer" type of deck. For the particular cases in which

$$\frac{A_s N_s l}{A_o} = \frac{1}{5}, \quad \frac{E A_s N_s l^3}{G t L^2} = 1,$$

and

$$\frac{A_s N_s l}{A_o} = \frac{1}{5}, \quad \frac{A_s N_s l^4}{I_G N_G L^2} = 100.$$

the variations of boom areas take the forms given in Fig. 9, page 647. These variations may be compared with that corresponding to negligible deck action.

Some experimental work on beams, with flanges consisting of reinforced sheets is referred to by Williams,* who concludes that the "plate-stringer" theory, as applied to cantilever box-beams, is in reasonable agreement with tests. For a bridge deck consisting of longitudinal stringers and transverse girders, a simple experimental study has been made by Allinson.† This model consists essentially of a half-deck, about 12 in. long and 6 in. wide, in which the booms and stringers are represented by elastic strings and the transverse girders by small xylonite beams. The relevant stiffnesses of the elastic strings and xylonite beams are derived experimentally. The model is held vertically with the upper end built into a rigid supporting beam (Fig. 10). To the extreme lower ends of the booms equal vertical loads are applied. The subsequent distribution of vertical displacements throughout the model is then studied. The *encastré* end of the model corresponds to the centre of the deck, $x = 0$. For the purposes of the theoretical analysis of the problem, the end loads on the booms are replaced by equivalent distributed loads along the whole lengths of the booms. In this way, it is possible to determine theoretically the vertical displacements of all points in the model half-deck. The displacements are functions of the relative stiffnesses of the stringers and transverse beams. A comparison of estimated and actual displacements is given in Fig. 11, in which the calculated and measured distributions of end loads in the half-deck are also shown. To eliminate possible compression stresses in the elastic strings, the whole frame is given an initial tension by applying uniform end loads to the stringers; when additional end loads are applied to the booms, the distorted form is of the type shown in Fig. 12, page 647.

It is concluded that simple stress-diffusion theories can be derived for the two types of decks consisting of deck plate and stringers, and transverse girders and stringers. The more complex problem in which the deck plate is reinforced with both heavy transverse girders and stringers is left for subsequent discussion. It is found that, owing to load diffusion, the component members of a bridge deck may be appreciably stressed. This means that the booms of the bridge are relieved of some of the load which they would otherwise carry. The extent of this stress relief at mid-span is found to depend upon the relative values of so-called "stringer," "plate" and "girder" parameters. If the booms of the bridge are connected by heavy transverse girders, there is found to be some advantage in attaching these girders rigidly to the booms; for this type of deck construction it is possible that some of the stringers of the tension deck may be compressed; this is a natural consequence of the actions of the transverse girders in diffusing loads throughout the deck. On taking into account the action of the deck, it is possible that the areas of the booms or flanges of a plate-girder bridge may be "curtailed" or reduced to an even greater extent than is commonly assumed in design practice.

* *Loc. cit.*

† M. G. Allinson, Dissertation for Honours Degree in Engineering, University of Bristol, 1952.

PHOTO-ELECTRIC PROTECTION OF HIGH-VOLTAGE EQUIPMENT.

THE high-voltage laboratory of W. T. Henley's Telegraph Works Company, Limited, 51, Hatton-garden, London, E.C.1, in which testing, development and research work on high-voltage cables and their associated accessories is carried out, is situated in six areas at the end of the cable production line at the company's Gravesend works. There is considerable movement of personnel round and through these areas, and to protect them it would have been inconvenient to erect high unclimbable barriers. Further, the use of such barriers would have prevented the size and shape of the areas from being altered to suit the particular type of apparatus under test. These difficulties have been overcome by surrounding the areas with a fence of light-gauge tubes which can easily be re-arranged and is painted bright red. It also carries distinctive "danger" signs. About 3 ft. inside this fence is a further barrier comprising beams of light which are projected on to photo-electric units at each corner of the area. These units, which were supplied by Radiovisor Parent, Limited, 1, Stanhope-street, London, N.W.1, are mounted on pedestals which, although heavy enough to prevent accidental movement, can easily be moved to new positions. Should any of the light rays be interrupted all power in the test area is automatically switched off and the impulse equipment is also earthed.

Each unit comprises a standard Radiovisor projection lamp and photo-electric receiver which are mounted on a common base. The former incorporates a mirror, which is adjustable to facilitate lining up, and a 3-in. diameter lens with baffles to minimise spread. The receiver contains the photo-electric cell which is mounted behind a spot diaphragm and collecting lens inside a long hood of rectangular section. It also contains a valve amplifier and relay. Both the projector and receiver can be turned so as to alter the angle of the projected beam in accordance with the shape of the area to be protected. The equipment is capable of operating over a maximum distance of about 200 ft. Each unit is wired to a selector panel in one of the control rooms so that the switchgear in each test area can be connected to it. The result is that this switchgear is tripped should the light beam be interrupted.

Radiovisor units have also been installed to project beams across one of the overhead crane tracks, so that if the crane should approach too closely to a "live" area the apparatus under test will be isolated. In addition, the crane will be stopped if impulse tests are in progress.

CIVIL AIRPORT FOR SILVER CITY AIRWAYS.—To facilitate handling the greatly increased traffic on the cross-channel vehicle air ferry services, Silver City Airways, Ltd., 1, Cumberland-place, London, W.1, have started work on a new airport, to be known as Ferryfield, at Lydd, near Dungeness. Ferryfield, which is expected to be in operation by midsummer next year, will be equipped for night flying and will be free from the water-logging and weather delays that have hindered ferry operation from Lympne airport. During the first ten months of 1953, 38,000 vehicles were ferried by Silver City; the corresponding figure for 1952 was 10,344.

SELF-ERECTING BUILDING CRANES.

A NEW range of tower building cranes of German design was introduced into this country recently by Abelson and Company (Engineers), Limited, Coventry-road, Sheldon, Birmingham, 26. Known as the Buildmaster rotary building cranes, the range at present covers three models, namely, the BDK 75, the BDK 150, and the BDK 300, the maximum lifting capacities of which are 1½ tons, 2½ tons, and 3 tons, respectively. Two of the cranes, namely, the BDK 75 and the BDK 150, are illustrated in Figs. 1 and 2, opposite, from which it will be seen that, in general, the design follows conventional lines with a single vertical mast surmounted by a jib. An outstanding feature of these cranes is the ease with which they can be set up, the three models being self-erecting in that the hoisting drum is used to raise the various parts into position. They can be run on curved track of unusually short radius.

Apart from differences in size and load-carrying capabilities and slight variations in detail design, the construction of the three models is more or less the same. Each may be considered as consisting of four major parts, namely, the undercarriage, the superstructure, the mast and the jib. The undercarriage is built up from channel-section and I-section steel beams and is arranged to operate on flat-bottomed rails, double-flanged wheels being fitted at both sides. At one side, single wheels are used and these are driven through spur gearing in the normal manner. At the opposite side, however, bogies consisting of two small wheels arranged in tandem are used and each bogie is designed so that it is free to castor, a double castoring effect being given by mounting the central pivoting point of each bogie at the end of a bracket which, in turn, is free to pivot about the frame. This arrangement permits curves of exceptionally small radius to be negotiated, the minimum radius, measured to the inner rail, being 13 ft. 4 in. for the BDK 75 and the BDK 150, and 22 ft. for the BDK 300. To avoid having to transport special ballast blocks to the building site, the undercarriage and superstructure are constructed so that they form cavities which can be filled with ordinary building bricks, it being possible to accommodate loads of 13,000 lb., 14,500 lb., and 26,500 lb., respectively, by this means.

The superstructure contains the hoisting and slewing motors together with their associated transmission assemblies and control gears. It is supported from the top of a substantial king post incorporated in the undercarriage and is arranged so that the complete assembly can be slewed through 360 deg. The slewing mechanism is of conventional design, consisting of a pinion driven by an electric motor through reduction gearing, and meshing with a large ring gear bolted to the undercarriage. To give the necessary stability, a number of rollers are installed at the base of the superstructure, and these are positioned so that they make contact with the inner periphery of the gear ring. These rollers are mounted eccentrically so that any wear can be taken up easily. Like the slewing mechanism, the hoisting gear also is of conventional design, but a three-speed gearbox is incorporated in the drive so as to give three different hoisting speeds. The load is held at all positions by a magnetically-operated contracting brake.

The mast and jib are of open lattice-work, all-welded construction, being built up mainly from angle sections of various sizes. The mast is supported at its base through horizontal pins arranged in the lowest practicable point of the superstructure, so as to give the maximum stability. It is held in position by fishplates which join the lower knuckle points to the apex of a triangulated framework fitted to the top of the superstructure. The jib is pivoted horizontally to the apex of the mast and is held in position by a substantial tie rod which joins the rear of the jib to the superstructure. The tie rod is designed, however, so that the jib can be set in any one of three positions, the maximum load varying, of course, according to the position in use. An overload cut-out is

SELF-ERECTING BUILDING CRANES.

FIG. 1. 2½-TON CRANE.

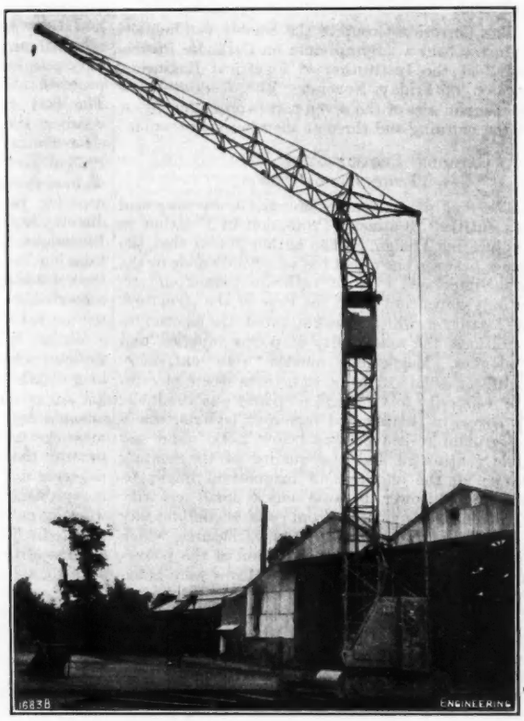
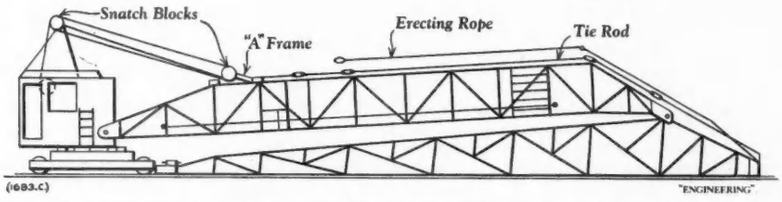


FIG. 2. 1¼-TON CRANE.

Fig. 3.



incorporated at the base of the tie rod, which is anchored to one arm of a bell-crank lever, the other arm of which is held in position by a friction clutch. Once the load exceeds the rated capacity of the crane, the clutch slips and in doing so operates a circuit-breaker in the electrical system.

The method employed for erecting the cranes on site is notably simple. After the undercarriage, together with the superstructure, has been placed on the rails, the base of the mast is joined through the appropriate pins to the superstructure, the main body of the mast lying along the ground. Two double-purchase snatch blocks are then placed in position, one of which is anchored to the triangulated framework installed on the top of the superstructure and the other to the apex of an A frame permanently fitted to the back of the tower at a point just above the lower knuckle. This frame, it should be added, is free to pivot about its joints with the mast. A wire rope is then reeved through the blocks and the free end wound on to the hoisting drum, after which the hoisting mechanism is used to raise the mast from the ground a sufficient amount to enable the jib to be placed below it in the position indicated diagrammatically in Fig. 3. The two parts are then joined together.

The tie rod which joins the rear of the jib to the superstructure is fastened to the jib at this stage and laid along the back of the mast, the tie rod being articulated to make this possible. One end of a wire rope known as the erecting rope is also joined to the rear of the jib and laid along the back of the mast to avoid having to install the hoisting rope when the mast is erected. This also is reeved when the jib and tower are in the positions shown in Fig. 3. With the aid of the hoisting mechanism, the tower is raised gradually until the jib hangs vertically downwards. The hoisting mechanism is then reversed until the jib head rests on the ground after which, with the hoisting mechanism still in reverse, the undercarriage is moved away from the jib until the jib and mast are at right angles to each other. The free end of the erecting rope is then secured to a bracket fitted to the rear of the mast just above the A frame and the hoisting mechanism used to raise the mast into the vertical position, the erecting rope holding the jib in the correct relative position with the mast during this operation. As soon as the mast is erected, it is bolted through the fishplates to the superstructure, the fishplates being located at the lower knuckle. The rope used in conjunction with the snatch blocks to raise the mast is then removed from the drum and the normal hoisting rope installed, after which the crane hook is hoisted until the dolly makes contact with the underside of the jib head, continuation of hoisting causing the jib to be raised to the desired position. Once the jib is in the correct position, the jib tie rod is joined to the overload safety cut-out.

The same methods are used to erect all three types of crane but in the case of the smallest, namely, the BDK 75, the jib is laid out in front, or as a continuation, of the mast during the earlier stages and not underneath the mast, as shown in Fig. 3. On the BDK 300 crane, the maximum load of 3 tons can only be handled when the jib is set to give a working radius of 29 ft. 7 in. The maximum working radius for this model is 65 ft. 8 in., at which the safe load is 1½ tons and the intermediate radius, 46 ft. 11 in., with a corresponding safe load of 2 tons. For the BDK 150, the working radii are 52 ft. 6 in., 36 ft. 1 in. and 23 ft. and the safe working loads 1 ton, 1½ tons and 2½ tons, respectively, the corresponding figures for the BDK 75, the smallest of the range, being 46 ft., 40 ft. and 23 ft. with safe working loads of 12½ cwt., 17 cwt., and 1¼ tons, respectively. The height of the pulley from the ground varies according to the position of the jib and these dimensions are: 86 ft., 118 ft. and 128 ft. 8 in. for the BDK 300; 69 ft., 96 ft. 6 in. and 105 ft. for the BDK 150; and 62 ft., 75 ft. and 84 ft. 8 in. for the BDK 75.

As already mentioned, each model is fitted with a gearbox giving three hoisting speeds and these are: 130 ft. per minute, 82 ft. per minute and 41 ft. per minute for the BDK 75; and 130 ft. per minute, 65 ft. per minute and 33 ft. per minute for the BDK 150 and BDK 300 models. The travelling speed for all models is 98 ft. per minute and the slewing speed 1 r.p.m. for the two larger models and 1·5 r.p.m. for the smallest model. Both the BDK 300 and BDK 150 models are provided with three control positions, namely, one on the undercarriage and two within the mast, the uppermost position being 49 ft. 3 in. from the ground in the case of the BDK 300 and 43 ft. 6 in. in the case of the BDK 150. The BDK 75, however, has only two control stations, one on the superstructure and the other in the top of the mast. The controls are easy to operate and during a demonstration it was noticed that in each case the top platform remained remarkably steady while the machine was travelling.

It is possible to convert all models to mechanical grabs, a section of the standard jib being used in the case of the BDK 75. This is unbolted from the main part of the jib and one end inserted in the position normally taken up by the base of the tower. The top of the jib is then tied by a special member to the superstructure and the machine then operated in the normal manner. On the two larger models, however, it has not proved possible to adapt the existing jibs for this purpose and extra jibs have to be used. The maximum loads that can be handled in the role of grab are 2½ tons for the BDK 300 and 30 cwt. for the BDK 150 and BDK 75 models. The gauge and wheelbase for the two smaller models are 9 ft. and 9 ft. 10 in., respectively, and for the largest model, 12 ft. 3 in. and 13 ft. 5 in., respectively.

CONFERENCE ON CATHODIC PROTECTION.

THE Corrosion Group of the Society of Chemical Industry held a "Symposium on Cathodic Protection" at the Institution of Electrical Engineers, London, on Friday, November 13. We give below brief summaries of the seven papers presented—four at the morning and three at the afternoon session.

CATHODIC PROTECTION IN RELATION TO ENGINEERING DESIGN.

The first paper was by Mr. K. A. Spencer and was entitled "Cathodic Protection in Relation to Engineering Design." The author stated that the choice between the use of the sacrificial anode or the power-impressed type of cathodic protection was entirely dependent upon the type of the structure, the locality in which it was situated, the electrolyte conditions, the availability of power supplies, and economics. Magnesium anodes were extremely useful for isolated marine structures where electrolyte resistivity was low and no power was available. Moreover, in complicated pipework layouts, where the ground resistance was below 2,500 ohms per cubic centimetre and the quality of the coating was good, the adoption of magnesium might be preferred to power, because only a small quantity of current was available from each anode and any possibility of damage to adjacent structures, which could occur by improper application of the power-impressed system, was avoided. Means were being developed for the cathodic protection of the interiors of pipelines with a minimum of increased resistance to flow. The use of manholes where anodes could be inserted through stuffing boxes without line shut-down, and with intermediate test points, was in hand. The success or failure of such a system depended to a large extent on the coating quality and on the electrical resistivity of the fluid being conveyed, but successful application might be possible on pipelines of 2 ft. diameter and upwards. The footings of pylons for carrying overhead power-transmission lines suffered from corrosion where the steel was in contact with soil or water. Cathodic protection could be afforded in such cases but advantage should be taken of the earthing wire that ran along the top of the pylons to give electrical continuity between the pylons.

INFLUENCE OF COMPOSITION OF ANODES.

The second paper dealt with the "Influence of the Composition of Magnesium Anodes on their Efficiency," and was by Mr. M. Oudeman, of the Royal Dutch Shell Laboratory, Amsterdam. He stated that some of the magnesium anodes used in the protection of a buried pipeline had been found to be abnormally inefficient, being excessively corroded and yielding small currents. Examination had shown them to differ considerably in composition from anodes of satisfactory performance in having high contents (up to 12 per cent.) of aluminium and also considerable quantities of general impurities. Moreover, investigation had suggested that the anodes had undergone some intercrystalline corrosion. A laboratory method for the assessment of anode efficiency had been devised. The material to be tested was connected to steel and immersed in aerated sea water, through a variable resistance used to keep the anode-current density at 300 milliamperes per square foot. This method had been found capable of revealing inefficient anode material and had also been used to study variation of anode efficiency with temperature.

CATHODIC PROTECTION IN BELGIUM.

"The Development of Cathodic Protection in Belgium" was the title of the third paper; it was by Mr. A. Weiler, of the Société de Distribution du Gaz, Brussels. He stated that the campaign against stray currents, which many authorities considered to be only a particular case of corrosion, had led to the general adoption of cathodic protection. The efficiency and economy of this method had now been abundantly demonstrated. Belgium was a country having a dense population living in towns very near to one another. This circumstance, which had favoured the construction of inter-connected gas grids, was also responsible for the building of many electrified railways and tramway lines laid in the same districts and the rails of which often ran parallel to the gas mains. In 1932 a pipe having a wall thickness of 0·28 in. had been found to be perforated after only six months' service. The conviction arose that the only possible solution of the problem was cathodic protection, and experiments had been put in hand. The first experiment, on cathodic protection by bonding the pipeline to the return circuit of an electrified transport system, had been made in 1933 in the presence of representatives of the owners of buried telephone and high-tension cables. The negative pole of the substation had been joined directly to the pipeline by means of a heavy cable. Investigation had shown that the pipeline was bringing 70 per cent. of the total current back to the substation and that the protection of the pipeline extended for an appreciable distance beyond the section fed by the substation.

Within two or three years of these early trials, similar schemes had been installed to protect long-distance pipelines wherever this was practicable. In some cases, however, where pipelines were affected by stray currents from the railways the measures referred to above could not be employed because the distance between the pipeline and the negative rail was too great. In such cases either independent buried anodes or appliances for withdrawing current using the rails as anode, had been adopted. The second solution had been chosen in the majority of cases. In Belgium, pipelines had also to be protected when stray currents were absent. For this purpose sacrificial zinc anodes had been used since 1937 and sacrificial magnesium anodes since 1946.

ECONOMIC ASPECTS OF CORROSION CONTROL.

The fourth paper, by Mr. D. H. Lewis and Mr. O. C. Mudd of the Shell Pipeline Corporation, Houston, Texas, U.S.A., was entitled "Economic Aspects of Corrosion Control." These authors stated that the first sections of the Shell Company's crude-oil pipeline system had been constructed in 1917, and by 1931 the length of the system had been increased to 3,380 miles of trunk lines extending over portions of seven States. The soil conditions ranged from the comparatively passive loams of the Mississippi-River watershed to the highly-active soils of West Texas and the heterogeneous soils of the Gulf Coast region. Protective coatings and cathodic protection each had advantages and limitations, and under severely corrosive conditions, the two systems, each supplementing the other, produced optimum results. Corrosion control was most effective and economical when undertaken as a preventive rather than a remedial measure. The success of any corrosion control programme depended on personnel, continuity of effort and the complete support of the management. The personnel should have a general knowledge of the basic sciences and a working knowledge of electro-chemistry and soil constituents. Essential also were temperament and a capacity for detail, initiative, and integrity to work with the minimum of supervision, and the imagination to deal with all the variations imposed by nature and civilisation. Records should be kept of all the observed effects of corrosion, the extent of the damage should be measured or photographed and the costs of corrosion incidents determined. Corrosion mitigation work, like any other business activity, must either show a profit or effect savings evidenced by comprehensive records and data. The Shell Pipeline Corporation conservatively estimated the tangible net savings from 15 years of concerted effort at 2½ million dols.

CATHODIC PROTECTION IN MIDDLE EAST.

The first paper considered at the afternoon session was on the subject of "Cathodic Protection and Control of Corrosion in the Middle East," and was by Mr. W. C. R. Whalley, of the Iraq Petroleum Company, Limited, Tripoli, Lebanon. Mr. Whalley stated that cathodic protection in the Middle East was confined at present to petroleum installations. Cathodic protection, however, should be considered as an adjunct to an impervious insulating coating. Wherever possible, new structures should be adequately coated at the time of construction. Bare structures had often been successfully protected but the current densities in such cases were necessarily heavy and only a restricted portion of the structure could be covered by a single installation. In the Middle East, conditions varied widely from place to place and this circumstance was reflected in the widely differing types of cathodic-protection installations encountered. Galvanic anodes found considerable application. This means of cathodic protection was restricted effectively to locations where soil conditions were such that the overall resistance of the circuit was low. Sea water, salt flats and marshy areas were locations favourable to the use of galvanic anodes. Magnesium was invariably used and standard types of anodes were employed, namely, a long cylinder or ingot weighing either 20 lb. or 60 lb. Some use had been made of hemispherical anodes weighing 150 lb. This form was particularly suited to marine installations on account of its long life, a spherical or hemispherical form giving a high ratio of weight to surface. The cathodic protection of an isolated pipeline might be regarded as a simple case compared with that of a tank farm or pump station where a network of pipes was found together with various other structures. The difficulty of protecting cathodically the bare base plates of a tank had led to the introduction of a system of pre-coating these plates with a high-temperature hard grade of bitumen-base enamel applied hot. By this means more than 98 per cent. of the bottom plates of a tank were effectively coated and insulated from contact with the soil. The cathodic protection of the remaining scattered bare portions should be simple and effective.

CATHODIC PROTECTION OF CANADIAN NAVAL VESSELS.

The second paper considered at the afternoon session concerned "Cathodic Protection as Applied to Royal Canadian Naval Vessels in Active Service." The author, Mr. K. N. Barnard, of the Naval Research Establishment, Dartmouth, Nova Scotia, stated that, since 1946, experience had indicated that cathodic protection, in conjunction with paint, was an economical system for preventing the corrosion and fouling of active as well as inactive ships in sea water. There were four types of anode material from which to choose, namely, magnesium, steel, graphite and platinum. The first three had been used successfully for a number of years, and the fourth, the platinum anode, was now just being tried. By extending the period between dry-dockings, the cost of a cathodic protection scheme was self-amortising on dry-docking charges alone. Furthermore, by extending the period between dry-dockings, the overall efficiency of an active ship was extended, since, for naval ships, less time was spent in "de-storing, re-storing, de-ammunitioning and re-ammunitioning." For a merchant ship, there was a shorter overall turn-round time. Finally, provided good maintenance practice were followed internally there should be no costly replacement of hull plating and rivets.

CATHODIC PROTECTION IN THE ROYAL NAVY.

The last paper dealt with at the conference concerned "Cathodic Protection, its Application to Ships and Establishments of the Royal Navy." It was by Mr. J. T. Crennell, of the Royal Naval Scientific Service, H.M. Dockyard, Portsmouth, who stated that cathodic protection of the outer bottoms of H.M. ships was at present applied to the Reserve Fleet only. Single ships were protected by magnesium anodes, groups of ships by impressed current. Cathodic protection was also being applied to floating docks and to jetties and other structures in the sea, as well as to underground pipelines. A special form of silver-silver chloride electrode and a voltmeter were used for measuring pipeline potentials. In enclosed spaces on board ship, which might be filled with seawater, cathodic protection involved a risk of explosive hydrogen collecting in pockets. Zinc anodes seemed the only safe and simple agents and laboratory experiments had shown the improved performance of high-purity zinc or of zinc alloyed with 1 per cent. of magnesium. So far as observations had gone, when an anti-fouling paint was applied over coats of anti-corrosive paint, cathodic protection had no effect on the efficiency of the anti-fouling coating.

625-H.P. DIESEL-HYDRAULIC LOCOMOTIVES.

Two Diesel-hydraulic locomotives have recently been built at the works of the North British Locomotive Company, Limited, 110, Flemington-street, Springburn, Glasgow, N., to the design requirements of the Mauritius Railways and the Crown Agents for the Colonies. One of them is shown in Fig. 2. They are fitted with standard Paxman RPH-type Diesel engines. A demonstration run, with the two locomotives coupled together, was made last week from Glasgow to Edinburgh and back.

The engines have 12 cylinders in V-formation and, on the 12-hour British Standard rating, give 625 h.p. at 1,250 r.p.m. The transmission is a Voith-North British hydraulic design, with a two-speed final drive, of the type described in ENGINEERING, vol. 171, page 720 (1951). The locomotives will operate between Port Louis Central Station, Curepipe and Mahebourg, a distance of 32 miles rising from sea level to 1,840 ft. at Curepipe, which is about half-way between the terminal stations. The gradients vary up to a maximum of 1 in 26 and the minimum curve has a radius of 300 ft. The two locomotives are designed to be used either singly or together, when they are connected electrically by jumper cable and pneumatically by air hoses. The controls of the locomotives are then operated from the leading unit, the second being driverless. Fig. 2, herewith, shows the efficiency of the locomotives and their performance at each speed range. When the locomotives are working together the net horse-power at the transmission input shafts is 1,150.

The locomotives are six-coupled and the power to the wheels is transmitted from the jackshaft which drives through side-rods. The frame is a welded-plate structure braced and stayed. The stretchers, brackets and other fittings which may have to be removed when repairs are being made are secured by fitted bolts. The main bearing springs are of the laminated type and are compensated on the centre and trailing axles at the cab end. The axle-boxes are fitted with Timken roller bearings and are oil lubricated. The liners fitted to the axle-boxes are made from manganese steel and require no lubrication. Radiators, one of which can be seen in the illustration, are provided on each side of the engine housing and the air is drawn in by a vertically-mounted fan and expelled through the top of the housing. Three sections in the radiators provide for cooling the engine water, lubricating oil and transmission oil.

The leading dimensions and other particulars are given in the accompanying Table.

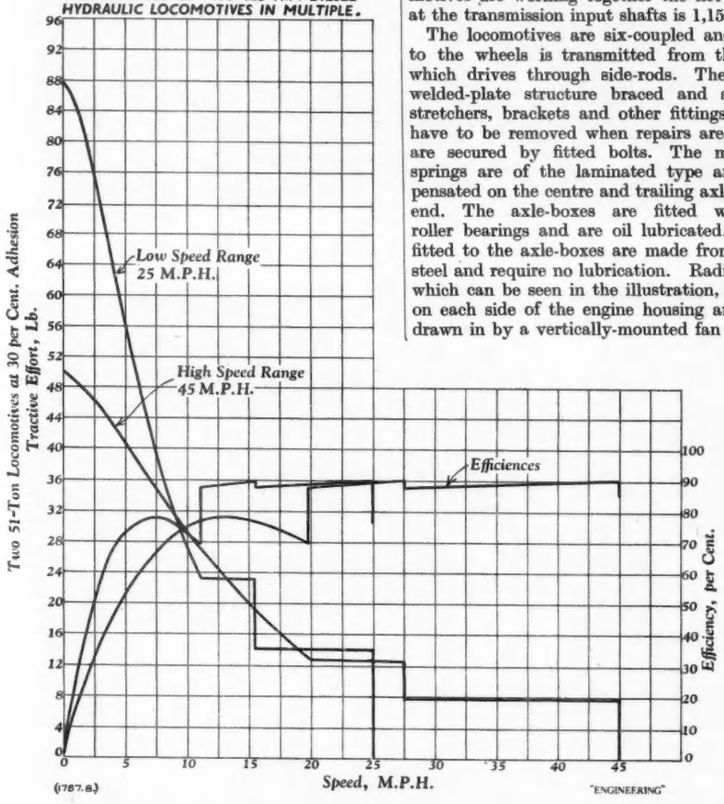
Gauge	4 ft. 8½ in.
Length over buffers	29 ft. 1½ in.
Maximum height	11 ft. 6 in.
Maximum width	8 ft. 6 in.
Wheel base	11 ft. 0 in.
Wheel diameter	3 ft. 6 in.
Total weight in working order	51 tons
Maximum tractive effort, low-speed range	35,800
Maximum tractive effort, high-speed range	23,000
Maximum speed, low-speed range	25 m.p.h.
Maximum speed, high-speed range	45 m.p.h.
Fuel-oil capacity	600 gallons

The engine has a bore of 7 in. and a stroke of 7¾ in. and is connected to the transmission through a Holset flexible coupling and cardan shaft. Twin Brown Boveri turbo-chargers driven by the engine exhaust gases are fitted and the final exhaust is ducted out through the roof. The air intakes to the turbo-charger are fed through the usual type of circular filters, which are integral with the blower casing. The engine speed is governed by a centrifugal type of hydraulic governor driven by bevel gearing from the end of the camshaft, and in the event of complete lubrication-oil failure it stops the engine. The engine speed is controlled from the cab by a self-lapping type of throttle valve which actuates a pneumatic servo-control.

The hydraulic transmission has three fluid circuits: a torque-converter for starting and low speeds; and two fluid couplings, one for the medium-speed and one for the high-speed range. The torque-converter and fluid couplings are self-contained, and are engaged by filling and disengaged by emptying. A fully-automatic type of governor controls their engagement according to the speed of the locomotive and it is operated by the movement of the throttle valve, which energises the solenoid controlling the filling valve. The valve cannot be opened unless the direction lever is in either the forward or reverse position. When the filling valve is opened the oil from the pressure pump, which also lubricates the gears and bearings, supplies oil to the governor, whence it is directed to the converter. As the throttle is opened the engine speed increases until the rail speed actuates the governor and this, in turn, directs the oil to the first coupling, the converter emptying automatically. If the rail speed is further increased the governor then directs the oil to the second coupling and empties the first coupling. The cycle reverses with a decrease in the rail speed, the oil circuits engaging and disengaging smoothly. The final drive, reverse and speed-change gearboxes are pneumatically operated and are protected by interlocking devices. The engine and transmission are also protected by excess-temperature and pressure-operated switches in the water and oil circuits, and a water-level switch in the radiator. Should overheating take place, the engine speed is automatically reduced to idling and the filling valve closed. Warning lights show which section is at fault. With low-water conditions the engine cannot be started before the fault is corrected.

A Westinghouse control system and both vacuum and air brakes are fitted, and a connection to the train-braking system. Both the air compressor and the vacuum exhauster are driven by belts from the engine crankshaft. The compressed-air supply is also used for operating the sanding controls, horn and windscreen wipers. A dead-man type of control gear is fitted, which automatically reduces the engine revolutions to idling after a delay of approximately five seconds if the driver's foot is removed from the pedal. The driver's desk is arranged so that the controls can be operated from either side. The reversing handle is placed in the centre, together with its indicator lights and the selector handle; this has three positions—off, engine start, and control. On each side are three levers for operating the throttle-control valve, the air brake and the vacuum brake. The engine stop-and-start lever is placed on the right-hand side of the desk, and the high-speed and low-speed selector valve is mounted on the driver's desk with an adjacent indicator which shows the position of the respective gears.

Fig. 1.
PERFORMANCE OF TWO 625-H.P. DIESEL HYDRAULIC LOCOMOTIVES IN MULTIPLE.



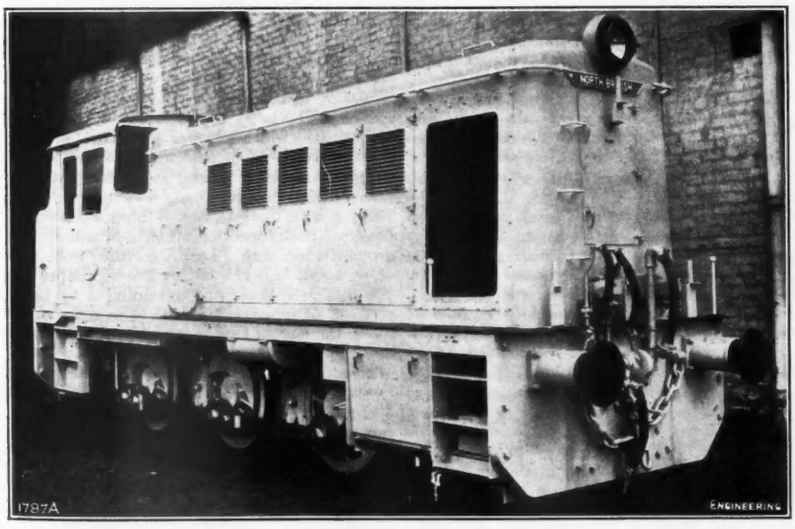


FIG. 2.

THE BUILDING EXHIBITION AT OLYMPIA.

THE Building Trades Exhibition, probably one of the oldest of all the British trade exhibitions, opened for the twenty-fifth occasion, at Olympia, London, on Wednesday, November 18, and will continue until Wednesday, December 2. About 500 exhibitors are displaying their products on nearly 600 stands. The comprehensive display of materials and equipment, and the many demonstrations of up-to-date building techniques, have been designed to interest and help all members of the building trade, from the largest contractor to the smallest of local builders.

LORRY LOADER.

The time lost by lorries waiting for loading or unloading facilities can, it is claimed, be reduced by fitting the lorry with the new type of loader being made by Lorry Loaders, Limited, a subsidiary of R. H. Neal and Company, Limited, Ealing, London, W.5. The new loader, shown in Fig. 1, herewith, is the principal exhibit on a stand which is otherwise devoted to a display of photographs and models of mobile cranes, including the now well-known travelling tower crane, made by the parent company.

The lorry loader is a hydraulic crane with telescopic jib; it has a load capacity of 1½ tons when the jib length is 5 ft. 6 in., or of 10 cwt. at 11 ft. 10 in. It is easily fitted to nearly any type of lorry, which can then be loaded and unloaded by the driver without other assistance. Simple in action, a single lever (at an easily reached level) controls the positive motions of hoisting and lowering, and power-driven slewing is available through 180 deg. When not in use, the jib, which is telescopic, is stowed behind the cab. As can be seen from the illustration, to relieve the lorry chassis and springs from strain when goods are being handled, the loader is fitted with a hydraulically-operated support leg. When the lorry is travelling, there is no side overhang and the main pillar of the crane is only 6 to 9 in. higher than the roof of the cab, depending on the type of lorry.

POWER FLOAT FOR CONCRETE FLOORS.

As specialists in all forms of floor-maintenance equipment, the Columbus-Dixon Organisation, Limited, Empire-way, Wembley, Middlesex, are showing a number of power-operated machines for cleaning and re-furbishing all types of floor. The "Senior" and "Junior" machines are capable of performing the combined tasks of scrubbing, polishing, dry cleaning and power scraping at rates approaching 3,000 sq. ft. per hour; other machines on view include floor-drying machines and industrial vacuum cleaners. The display also includes samples of the company's full range of brushes as well as surfacing and smoothing discs.

On show for the first time at an exhibition is the company's new power float illustrated in Fig. 2, herewith. The float, which is available either, electrically powered as illustrated or, alternatively, with a 3·5-h.p. petrol engine, has been designed for finishing the surface of floors laid in a stiff concrete mix not amenable to hand floating. The great advantage to be obtained by the use of dry concrete is the far higher strength and durability of the floor that is achieved. Before the introduction of power floats it was necessary for the concrete to be thinned down with water so that it could be hand-floated by a plasterer; the resultant concrete had little strength and, due to the excessive degree of shrinkage that occurred, considerable cracking inevitably took place within a short while of the floor being laid. The use of the power float will permit the concrete to be placed in such a stiff condition that the operator will be able to stand on it while controlling the float and the concrete will have those qualities which have been lacking in the wet mixes formerly used.

"CALFDOZER."

From the wide range of earth-moving and other contractors' plant that they make, Aveling-Barford, Limited, Grantham, are showing only two small machines, a calfdozer, illustrated in Fig. 3, opposite, and a dumper having a capacity of only ½ cub. yard. Both these machines are already proving themselves to be of great value to builders both at home and abroad. The calfdozer is driven by a single-cylinder water-cooled four-stroke engine, and is fitted with a blade 4 ft. 6 in. wide which can be swung to either side for angle dozing. The machine is fully tracked, each track being driven independently through double-acting clutches, so that one track can be in reverse while the other is moving forward, thereby developing the manœuvrability that is required for working in confined spaces. For cutting into hard ground, alternative equipment to the blade has been provided in the form of a two-line ripping attachment. The overall dimensions of the calfdozer are 7 ft. 1½ in. long, 4 ft. 7 in. high by 4 ft. 6 in. over the blade; in working order, it weighs 32 cwt.

HALF CUBIC-YARD DUMPER.

The small dumper, shown in Fig. 4 and exhibited by Aveling-Barford has a hopper of ½ cub. yd. capacity. It is a three-wheel machine designed to operate over the rough ground found on building sites and it is driven by a single-cylinder petrol engine developing 4·5 brake horse-power. The power is transmitted to the large-diameter load-carrying wheels by a positive system of gear and chain drives which achieves the maximum degree of traction available. Controlling the dumper is very simple: one lever starts, stops and reverses the machine and no gear changes have been provided. Driving with the load behind him, as shown in the illustration, the operator has an unbroken view of the ground before him. Loading, either from a mixer or by hand, is facilitated by the wide open hopper that has been fitted and unloading is by the usual method of gravity tipping. For carrying piece loads, the hopper can be mounted with a level base and, for carrying coke, coal and similar loads, an alternative, deeper hopper is available. In both forward and reverse gear the speed of the dumper is 3 m.p.h. A load of 1,350 lb. or 7 cub. ft. of wet concrete can be carried.

DOUBLE-ENDED TENONING MACHINE.

Wadkin, Limited, Green-lane, Leicester, are showing a full selection of their woodworking machines. The display includes both high-production types and general-purpose machines. Among the latest additions to the range is a new 12 in.

EXHIBITS AT THE BUILDING EXHIBITION.

FIG. 1. LORRY LOADER; R. H. NEAL & CO., LTD.

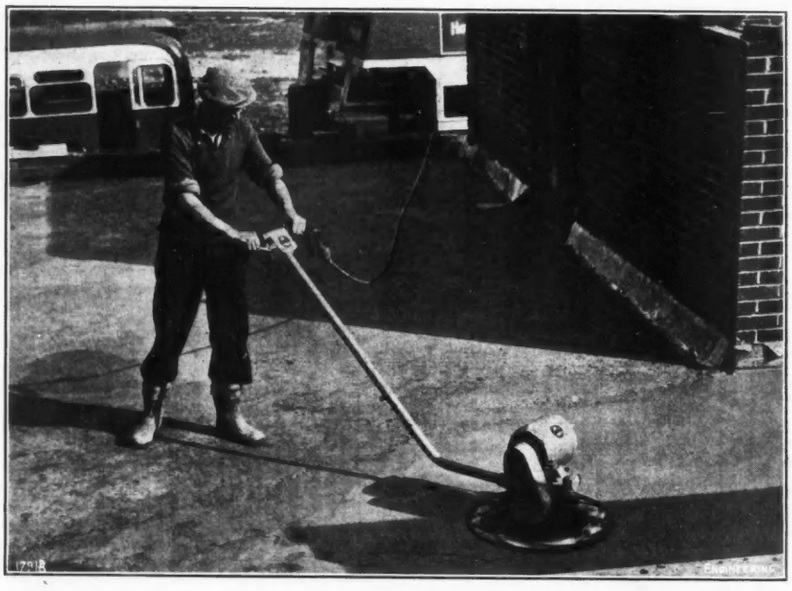


FIG. 2. POWER FLOAT FOR CONCRETE FLOORS; THE COLUMBUS-DIXON ORGANISATION, LTD.

EXHIBITS AT THE BUILDING EXHIBITION.

FIG. 3. "CALFDOZER"; AVELING-BARFORD, LTD.

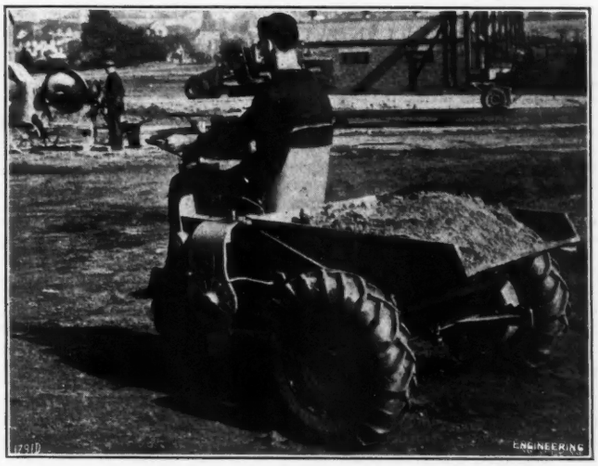


FIG. 4. HALF CUBIC-YARD DUMPER; AVELING-BARFORD, LTD.

by 5 in. high-speed planer and moulder, the first of its size to have been made by the company since the war. In general, the design closely follows that of the smaller 8 in. by 4 in. machine, having fully-enclosed ball-bearing mounted feed rolls driven by a chain running in an oil bath. The new model is designed as a five-headed machine, but provision has been made for an optional sixth head; each tool-head is motored independently to give speeds of up to 6,000 r.p.m. Refinements include centralised control by four-position drum switches, duplicated inching controls located at each end of the machine, electric braking, built-in dust hoods, etc.

The largest of the high-production machines on show is the double-ended tenoner illustrated in Fig. 5, on page 656. Though designed primarily for tenoning, this machine is able to cope with a great variety of work as it can be equipped to carry as many as 20 independent motorised heads simultaneously. Tool speeds of 6,000 r.p.m. or more can be obtained; the controls are all operated from a single panel; automatic lubrication has been fitted; regenerative braking is employed on the cutter heads; and built-in dust collectors have been incorporated as standard equipment.

24-IN. PANEL PLANER.

Among the planing machines included in Wadkin's display is a new 24-in. sectional-feed thicknesser and panel planer. It is shown in Fig. 6, on page 656. Fitted with a four-bladed cylindrical cutting block running at 4,200 r.p.m. and a precision-ground work table, the maximum rate of feed obtainable is 100 ft. per minute. A four-point lock to the table ensures absolute rigidity. The built-in grinder and jointer is a new feature for this type of machine which contributes appreciably to the high standard of finish which can be attained. Other machines displayed include a heavy-duty spindle moulder, other planers, single-end tenoners, a chain-and-chisel mortiser and cross-cut saws. Among the last-mentioned is a new model, a hydraulic cross-cut saw designed to handle timber up to 12½ in. wide by 5 in. deep; this is smaller than other machines of this type made by the company, but the reduced stroke has allowed the main frame to be made smaller, so effecting reductions in cost and floor space, but still providing a machine with a capacity adequate for many users.

AUTOMATIC PRESSURE WATER UNIT.

A comprehensive range of centrifugal pumps is to be found on the stand of James Beresford and Son, Limited, Marston-green, Birmingham, who are the makers of, among other types, a submersible electric pump which they state is now installed in more than 85 per cent. of the boreholes in the United Kingdom. The exhibits include, in addition to examples of this pump, several versions of the "Stork" single-stage pump, which may be driven either electrically or by a petrol engine; it can also be fitted with fast and loose pulleys suitable for a belt drive. The "Stork" can be supplied either mounted on a trolley or in many other forms for use in the home, on the farm, in the factory or in the fields and yard. They are made for outputs of 1,200 to 150 gallons per hour against a maximum head of 180 ft. and they are self-priming up to 27 ft. As multi-stage pumps, the maximum capacity can be increased to 50,000 gallons per hour against a 10-ft. head or to 115 gallons per hour against a 1,000-ft. head. They can be supplied as either self-priming or non-self-priming pumps.

Other equipment on this stand includes the automatic-pressure water unit illustrated in Fig. 7, on page 656. This type of unit provides a reliable and automatic means of obtaining a constant-head supply without installing an overhead storage tank. The unit normally incorporates an electrically-driven "Stork" centrifugal self-priming pump to raise the water from the well, a combined water and pressure-storage tank and a switching arrangement which starts the pump when the quantity of water drawn off is sufficient to have lowered the pressure within the tank to some predetermined figure. As the pump is normally only in operation intermittently, the system is quite economical in operation. The water supply from the system can be at any predetermined pressure, a convenient figure being a mean pressure of 33 lb. per square inch.

(To be continued.)

DETERGENTS IN RIVERS.—The Severn River Board are to carry out a survey of the Rivers Severn and Avon over a length of 200 miles, in order to obtain information concerning the effect of detergents. Fifty permanent sampling stations are to be established on the banks of the two rivers, and samples of water will be taken regularly for analysis. The Board have stated that the only effect of the increasing use of detergents, so far, is the production of large quantities of foam, but the survey will collect as many data as possible. The combined effect of detergents, sewage, and industrial effluents will also be studied.

SHROPSHIRE DERAILMENT.—Traffic on the main line of British Railways (Western Region), at Condover, Shropshire, was delayed when a goods train broke in two on November 2. The major part of a train of 48 wagons became detached as it was descending an incline, and the driver accelerated to keep his engine and three wagons ahead of the remainder of the train. The engine passed over the points leading to a siding at Condover station, and the signalman there then diverted the runaway part of the train into the siding. It collided with a stationary goods train, and several wagons were derailed and damaged, but owing to the signalman's action, no damage was caused to the main tracks and the delay to traffic was slight.

THE "PRINCESS" FLYING BOAT.

To clarify the attitude of British Overseas Airways Corporation to the possibility of operating the Saunders-Roe Princess flying boat, Sir Miles Thomas, the chairman of the Corporation has issued a statement to all members of the B.O.A.C. staff.

"As custodians of tax-payers' money," Sir Miles says, "we can only contemplate operating aircraft that show a possibility of making a reasonable financial return. With its original engines, the Princess flying boat was, in our assessment, uneconomic. Therefore, we said that we would not operate them commercially on our scheduled services. But we always realised that engines might be developed that would give the boats an economic performance. For that reason, we seconded our Captain H. W. C. Alger to Saunders-Roe nearly three years ago, and he has assisted in the development of these boats, contributing to their design much of the unique flying-boat experience that is in the possession of the Corporation. Moreover, in September, 1952, we offered to set up a Marine Development Flight as part of the Corporation's organisation but separate and distinct from our normal commercial operations. This Marine Development Flight would have carried out such development and operational work as was required. We were told, however, that it was doubtful whether operations on the scale we had contemplated would materialise for a few years and it was suggested that the matter should be deferred until nearer the time when more efficient engines would be available. As soon as the Bristol Aeroplane Company, in collaboration with Saunders-Roe, had reached a stage in the development work on a type of engine which gave promise that the Princess would be an economic proposition, the Corporation naturally showed renewed interest in the boat. . . . Our broad proposals are that when the hulls have been fitted with engines that will give them a competitive commercial performance we will buy them at the commercial price then current, and operate them on world-wide routes. It is unlikely that the appropriate engines will be developed before 1958. In the intervening period, suitable preparations for operating the boats on passenger-and-freight routes will be developed. It will be appreciated that the Corporation is in a unique position to make the best showing of these aircraft, in which so much public money has been invested."

Aquila Airways also are interested in operating the Princess flying boat, and on November 5 made an offer to the Ministry of Supply for the purchase of the three Princess aircraft.

GLASGOW WATER SUPPLY.—Loch Katrine, the principal source of Glasgow's water supply, overflowed on November 12 for the first time in 599 days, following a rainfall of 6·84 in. in nine days. The level rose 3 ft., corresponding to a storage of 2,625·4 million gallons.

NOTES FROM THE INDUSTRIAL CENTRES.

SCOTLAND.

Scottish Iron and Steel Trade.—Stimulated by a good inland demand, particularly from shipbuilders and other users of plates, the steel industry continues to operate at nearly full capacity. The output of ingots and castings during October was at an annual rate of 2,407,500 tons and this gave an average for the first 10 months of the year of 2,320,300 tons. These figures compared with 2,309,900 tons in October of last year and a 10-monthly average of 2,065,000 tons. Reflecting a greatly improved supply of heavy steel scrap, the production of pig iron from the nine blast furnaces in operation in the district declined slightly in October to the annual equivalent of 877,100 tons, as compared with 878,900 tons last year. This made the 10-monthly average 865,200 tons, against 878,100 tons in 1952.

Machinery for Fish-Processing Factories.—The Herring Industry Board, who plan to open a new reduction factory at Peterhead by next summer, are well forward with negotiations for premises and equipment. They have also acquired most of the plant needed for the enlargement of the existing factory at Stornoway, and contracts for the new buildings and the installation of machinery have been put out to tender.

Fire at Steelworks.—An outbreak of fire occurred on November 5 at a rolling mill of the Clyde Alloy Steel Co., Ltd., Netherton, near Motherwell, when a hot bar rolled into a pit and ignited a quantity of oil. Some damage was done to the electrical equipment.

Purchase of Aberdeen Shipyard.—It is announced that the firm of Alexander Hall & Co., Ltd., shipbuilders and engineers, Aberdeen, are to be acquired by Hall, Russell & Co., Ltd., also of Aberdeen. The latter are a subsidiary of the Burntisland Shipbuilding Co., Ltd., now owned by the Scottish and Mercantile Investment Co., Ltd. The business of Alexander Hall & Co. dates from 1790. The company's yard comprises ten berths capable of an annual output of some 6,000 tons of small craft. The engine works can turn out about 8,000 h.p. of propelling machinery per annum.

Exploratory Shafts for Opencast Coal Mining.—A French Benoto hammer grab, designed primarily for sinking wells in North Africa, has been successfully applied to put down 4½ ft. diameter exploratory shafts in connection with a new opencast coal project in the Lothians. The machine, which is mounted on a lorry, resembles a mobile drilling rig. The grab has three cutting shoes so arranged that, when they are drawn inwards, they fold up like petals. In operation the grab is hoisted up by winch and allowed to fall; its weight drives the cutting edges into the rock. The grab has a capacity of 20 cub. ft. Integral with the machine is an arrangement for lowering steel casing, together with a welding plant for joining the sections.

The Late Mr. A. McA. Morison.—Mr. Andrew McArthur Morison, F.C.M.S., M.Inst.N.A.,M.I.Mar.E., who was for 42 years a partner in the firm of McArthur Morison & Co., consulting engineers and marine surveyors, Glasgow, died at the age of 68 on November 7. As well as acting in a technical capacity for a number of Glasgow shipowners, Mr. Morison held the appointment of surveyor to the Registro Italiano. He was educated at Allan Glen's School, the Royal Technical College and the University of Glasgow, and served an apprenticehip in marine-engine building at the works of David Rowan & Co., Ltd.

CLEVELAND AND THE NORTHERN COUNTIES.

North-East Industrial and Development Association.—The North-East Development Association and the Northern Industrial Group, Newcastle-upon-Tyne, have been merged and, in future, will be known as the North-East Industrial and Development Association. Both organisations were formed some years ago to further the industrial development of the North-East. The merged organisation will have among its members representatives of local authorities, harbour and river authorities, development associations, industrial concerns, banks, trade-union organisations and co-operative societies.

Jarrow-Howdon Tyne Tunnel.—At a meeting of Northumberland County Council, Alderman D. Dawson, chairman of the Roads and Bridges Committee, dealt with a misconception which, he stated, had arisen regarding the proposed tunnel under the Tyne, between Jarrow and Howdon. He said that the Tyne Tunnel Committee were not seeking permission to proceed with the scheme immediately, but wanted to ensure that it retained its priority. People in other parts of the country were putting forward new schemes and trying to "jump the queue" for priority. The Joint Committee wished to ensure that the Tyne plan retained its place in the general programme when the Ministry of Transport decided to relax the restrictions on capital expenditure.

Developments at Westoe Colliery.—The Durham Divisional Coal Board are planning the sinking of another shaft at Westoe Colliery, South Shields, and, within a few years, the colliery will be the major producing unit of the Harton group of collieries. The new shaft will be equipped with modern skip-winding plant and be capable of drawing between 30,000 and 35,000 tons of coal weekly. It is expected that, in the course of time, Westoe Colliery will absorb the Harton and Whitburn pits. Re-organisation work is being carried out in the adjacent Boldon pit. At Boldon, mostly inland coal is being worked; at Westoe, coal reserves under the sea will be exploited. A new coal washer, to handle about 800 tons of coal an hour, is also being erected at Westoe.

Armstrong Whitworth Works, North Shields.—The North Shields works of Armstrong Whitworth & Co. (Pneumatic Tools), Ltd., were officially opened on November 6 by Mr. D. Heathcoat-Amory, Minister of State for Overseas Trade. The works were transferred from Gateshead to larger premises at North Shields two or three months ago. Armstrong Whitworth & Co. (Pneumatic Tools), Ltd., were taken over about three years ago by the Thor Power Tool Co., of America, and, since then, the firm's range of products has been steadily increased. Plans are in hand for producing another 25 types of tools during 1954. The new North Shields works cover 70,000 sq. ft., compared with the Gateshead works' area of 38,000 sq. ft.

Dry-Dock Scheme at South Shields.—Messrs. Brigham and Cowan, Ltd., ship-repairers, South Shields, have revised their plan for a new dry dock, and the proposed dock will now accommodate oil tankers of up to 38,000 tons deadweight capacity, compared with the original 32,000 tons. The dock will be 710 ft. by 95 ft. compared with the original 665 ft. by 90 ft., and will be almost identical with the dock now nearing completion across the Tyne, at the North Shields yard of Smith's Dock Co., Ltd. It is expected that a contract will be let this month and a start made by the end of the year on the scheme.

LANCASHIRE AND SOUTH YORKSHIRE.

The Freeing of Nickel.—Sheffield makers of special steels welcome the freeing of nickel from control. Mr. Frank A. Hurst, chairman and managing director of Samuel Osborn & Co., Ltd., Sheffield, regards the move as "opening the door to free exports and to free manufacture." Mr. Lewis Chapman, managing director of William Jessop & Sons, Ltd., states that, as far as may be necessary for technical purposes and practical applications, steel users will be able to obtain their traditional qualities, and steel makers will have to do less adjustment in trying to make steels meet particular specifications with less alloy than they would normally care to use.

The Growth of Competition.—Competition has become keener in steel and engineering. The latest advices received in Sheffield state that Swedish quality steels for export are reduced in price for most types because of the necessity of meeting competition from Germany, the United Kingdom and the United States. The general manager of the Steel, Peech & Tozer branch of the United Steel Companies Ltd., Mr. G. E. D. Halahan, has told the firm's ex-Servicemen's Association that, although the company's order book is satisfactory, customers are becoming more difficult to please, and that there was increasing need to see that steel sent out was as the customer wanted it.

Cheapening of Tungsten Ore.—The price of tungsten is falling as a result of a drop in the official selling prices of wolfram ore and scheelite. This follows a series of reductions which have brought down the price by 82*s.* 6*d.* a unit since mid-September. The latest fall was precipitated by cheap offerings from Burma. High prices of tungsten ore have stimulated a production which is now in excess of the demand.

THE MIDLANDS.

Sale of Sheet Rolling Mill.—The sheet rolling mill of Greenway Brothers, Ltd., Bilston, Staffordshire, has been sold by auction, and the equipment broken up. The mill, which produced black-steel sheets, and, formerly, galvanised flat and corrugated sheets as well, was one of the two remaining hand sheet mills in the Black Country. It was closed in July of this year, immediately after the other surviving mill, which belonged to the Midland Sheet Co., Ltd., West Bromwich, Staffordshire, ceased work. The Black Country still produces steel sheets in semi-mechanised mills.

Gilded Glass.—The Triplex Safety Glass Co., Ltd., King's Norton, Birmingham, 30, are installing plant for the production of toughened glass coated with a very thin film of gold, to be used in the prevention of icing on aircraft windows. The film of gold carries an electric current to heat the glass. The new plant will produce glass in flat sheets up to 3 ft. 6 in. long by 2 ft. wide, with a gold coating approximately 0.0000002 in. thick.

The Employment Position.—Unemployment figures for the Midland region are now lower than at any time for nearly two years. The official Ministry of Labour figures show that on October 12 the total number of unemployed in the area was 16,305, which represents a drop of 1,613 compared with September. It is pointed out that the total includes a considerable number registered as unemployed while they are changing jobs.

Parking Meters.—Leicester City Council have been authorised to purchase 50 parking meters from the United States. These meters will be installed in a car park for the present, until such time as their use on the roadside is legalised. Permission to import these meters has been granted by the Board of Trade on condition that future meters must be made in this country.

SOUTH-WEST ENGLAND AND SOUTH WALES.

Pre-Christmas Activities at the Mines.—As usual in the weeks before Christmas, coal production in the South Wales coalfield has steadily increased. In the week ended November 7, the output of saleable coal was 515,742 tons, the highest reached this year. Last December, production in the peak week was 516,672 tons.

Welsh-Coal Exports to France.—The South Wales coal-export trade with France, which has now reached its highest level since the early months of this year, should be maintained at least at the present level in the first quarter of 1954. In the current quarter, French purchases locally will amount to 80,000 tons, compared with only 14,000 tons in each of the two preceding quarters. Hopes of the maintenance of this trade have been entertained on the market for some weeks. Strength has been given to the reports during the past week by the visit to Cardiff of M. Pierre Burthe-Mique, commercial attaché to the French Embassy in London, who had talks with local coal exporters and pitwood importers. He afterwards described these as exploratory and expressed the view that it should be possible to improve both trades next year.

Threatened Closure of Pidwellt Colliery.—The 200 to 300 men who work at the Pidwellt Colliery, Rhymney, threatened with closure by the National Coal Board, have enlisted the support of the Rhymney Urban Council in their campaign to dissuade the Board from their intention. A deputation from the miners' lodge to the Council pointed out that there were ten years' reserves of coal in the pit. So far this year, the colliery had consistently exceeded its monthly target output of 3,000 tons.

Hydrochloric-Acid Plant, Pontypridd.—A new 350,000*l.* plant for Glamorgan Alkali & Acid Co., Ltd., at Rhydyfelin, near Pontypridd, has been officially opened by Lord Piercy, chairman of the Industrial and Commercial Finance Corporation and director of the Bank of England. The new project will supply the Treforest Chemical Co. with hydrochloric acid for the manufacture of gelatine. Mr. Leslie Leiner, chairman of the Treforest Chemical Co., said that gelatine had been produced by the company in Wales since 1939. Production at Treforest to-day stood, in quality and quantity, second to none in the world.

Repairs to M.S. "Raeburn."—After undergoing temporary repairs and stiffening at the Channel Dry Dock, Cardiff, the M.S. Raeburn, which, in September, lay for four days in a dangerous position across the Monkstone Rocks in the Bristol Channel, has arrived at Belfast to undergo repairs.

NOTICES OF MEETINGS.

It is requested that particulars for insertion in this column shall reach the Editor not later than Monday morning in the week preceding the date of the meeting.

Institution of Electrical Engineers.—*Radio Section:* Monday, November 23, 5.30 p.m., Victoria-embankment, W.C.2. "Loudspeaker Systems," by Major A. E. Falkus. *North-Eastern Centre:* Monday, November 23, 6.15 p.m., Neville Hall, Newcastle-upon-Tyne. "Design Features of Certain British Power Stations," by Mr. S. D. Whetman and Mr. A. E. Powell. *East Midland Centre:* Tuesday, November 24, 6.30 p.m., Gas Showrooms, Upper Parliament-street, Nottingham. Joint Meeting with the Institution of Mechanical Engineers (*East Midlands Branch*). "Technique and Development of Automatic Winding in Mine Shafts," by Mr. B. L. Metcalf and Mr. G. Cuttle. *London Students' Section:* Tuesday, November 24, 7 p.m., Victoria-embankment, W.C.2. "Machines, Animals and Information," by Mr. B. Z. de Ferranti. *Supply Section:* Wednesday, November 25, 5.30 p.m., Victoria-embankment, W.C.2. "A New Approach to the Theory and Operation of Electrostatic Precipitators for Use on Pulverised-Fuel Fired Boilers," by Mr. N. Troost.

Royal Society of Arts.—Monday, November 23, 6 p.m., John Adam-street, Adelphi, W.C.2. Cantor Lecture I.—"Alloys," by Mr. G. L. Bailey. Wednesday, November 25, 2.30 p.m. "Kuwait," by Mr. C. A. P. Southwell.

Institution of the Rubber Industry.—*Manchester Section:* Monday, November 23, 6.15 p.m., Engineers' Club, Manchester. "Heat Sensitisation of Natural Rubber Latex," by Dr. E. G. Cockbain.

Institution of Production Engineers.—*Sheffield Section:* Monday, November 23, 6.30 p.m., Grand Hotel, Sheffield. Informal Meeting. *Derby Section:* Monday, November 23, 7 p.m., College of Art, Green-lane, Derby. "Difficulties and Developments in Deep Drawing and Pressing," by Dr. J. D. Jevons. *Luton Section:* Tuesday, November 24, 7.15 p.m., Town Hall, Luton. "Education and Training in Administrative Engineering," by Mr. Winston Rodgers. *Western Section:* Wednesday, November 25, 7.15 p.m., Grand Hotel, Bristol. "Protection of Metal Components Against Atmospheric Corrosion," by Mr. N. R. Laban. *Shrewsbury Section:* Wednesday, November 25, 7.30 p.m., Shrewsbury Technical College, Shrewsbury. "Organisation and Use of Information in Industry," by Mr. G. Gilfillan. *South Wales Section:* Thursday, November 26, 6.45 p.m., South Wales Institute of Engineers, Park-place, Cardiff. "Fundamentals of Production Management," by Mr. M. Seaman. *Coventry Section:* Thursday, November 26, 7 p.m., Church House, Church-street, Rugby. "Contribution of Electricity to Industry," by Mr. L. Landon Goodman. *London Section:* Thursday, November 26, 7 p.m., Royal Empire Society, Northumberland-avenue, W.C.2. "Developments in Powder Metallurgy," by Mr. G. R. Bell. *Southern Section:* Thursday, November 26, 7.15 p.m., Polygon Hotel, Southampton. "Legal Aspects of Factory and Production Managements," by Mr. H. Peter Jost. *Lincoln Section:* Thursday, November 26, 7.30 p.m., Ruston Club, Unity-square, Lincoln. "Foundry Techniques," by Mr. G. R. Shotton.

Junior Institution of Engineers.—*North-Western Section:* Monday, November 23, 7 p.m., Engineers' Club, Manchester. Discussion on "Treatment of Industrial Effluent." *Institution:* Friday, November 27, 7 p.m., Townsend House, Greycoat-place, S.W.1. Annual Meeting.

Iron and Steel Institute.—Tuesday, November 24, 2.15 p.m., and Wednesday, November 25, 9.45 a.m., 4, Grosvenor-gardens, Westminster, S.W.1. Annual General Meeting. Wednesday, November 25, 2.15 p.m., and Thursday, November 26, 9.45 a.m. and 2.15 p.m., Symposium on "Sinter." For programme, see page 575.

Institute of Marine Engineers.—*Merseyside and North-Western Section:* Tuesday, November 24, 2.15 p.m., Royal Technical College, Salford. Junior Lecture on "Gas Turbines," by Mr. J. Hodge.

Institution of Civil Engineers.—*Railway Engineering Division:* Tuesday, November 24, 5.30 p.m., Great George-street, S.W.1. "Bridge Investigation, Ceylon Government Railways, 1949-1951," by Mr. Conrad Gribble. *Midlands Association:* Wednesday, November 25, 7 p.m., Loughborough College, Loughborough. "Civil-Engineering Work at Castle Donington Power Station," by Mr. J. T. Edwards.

Institute of Fuel.—Tuesday, November 24, 5.30 p.m. Institution of Mechanical Engineers, Storey's-gate, St. James's Park, S.W.1. "A National Fuel Policy," by Dr. F. M. H. Taylor. *Midland Section:* Thursday, November 26, 6 p.m., James Watt Institute, Birmingham. "Waste-Heat Recovery for Steam Raising," by Mr. C. Ungoed. *East Midland Section:* Thursday, November 26, 6.15 p.m., Gas Showrooms, Nottingham. "Effects of Carbonising Conditions on Coke Combustibility," by Mr. H. Bardgett. *Scottish Section:* Thursday, November 26, 7 p.m., Royal Technical College, Glasgow. "Coal Supplies from the Scottish Coalfields," by Mr. J. W. Anderson.

Reinforced Concrete Association.—Tuesday, November 24, 6.45 p.m., Engineers' Club, Manchester. "Developments in Prestressed-Concrete Construction," by Mr. A. J. Harris.

Society of Instrument Technology.—Tuesday, November 24, 7 p.m., Manson House, Portland-place, W.1. "Unusual Aspects of Automatic Control in the Chemical Industry," by Mr. R. D. Mylon.

Institution of Works Managers.—*Wolverhampton Branch:* Tuesday, November 24, 7 p.m., Star and Garter Royal Hotel, Wolverhampton. "Preventative Maintenance," by Mr. O. F. Lewis.

British Institution of Radio Engineers.—*West Midlands Section:* Tuesday, November 24, 7.15 p.m., Wolverhampton Technical College, Wulfruna-street, Wolverhampton. "Remote-Control Devices and Servo-mechanisms," by Mr. A. E. W. Hibbitt.

Association of Supervising Electrical Engineers.—*Coventry Branch:* Tuesday, November 24, 7.15 p.m., Technical College, Coventry. "Heating and Ventilating," by Mr. E. E. Smith. *Luton Branch:* Thursday, November 26, 8 p.m., George Hotel, Luton. "Vocational Education and the Supervising Electrical Engineer," by Mr. W. H. Brooks.

Chemical Society.—*Glasgow Branch:* Wednesday, November 25, 5.45 p.m., The University, Glasgow. Centenary Lecture. "Applications of the Separation of Large Molecules and Colloidal Particles," by Professor A. Tiselius. *Newcastle and Durham Branch:* Friday, November 27, 5.30 p.m., King's College, Newcastle-upon-Tyne. "Optical Activity and the Study of Chemical Reactions," by Dr. J. Kenyon, F.R.S. *South Wales Branch:* Friday, November 27, 5.30 p.m., University College, Swansea. "Mechanism of Reactions Between Gases and Solids," by Dr. J. S. Anderson, F.R.S.

Liverpool Engineering Society.—Wednesday, November 25, 6 p.m., 24, Dale-street, Liverpool. "East-Coast Flood Damage," by Mr. J. V. Spalding.

Institution of Mechanical Engineers.—*Yorkshire Branch:* Wednesday, November 25, 6.30 p.m., The University, Sheffield. "Wire Drawing and Wire-Drawing Machinery," by Mr. S. R. Richards. *Southern Branch:* Wednesday, November 25, 7 p.m., Brighton Technical College, Brighton. "Production of a Technical Newspaper," by Mr. B. W. Pendred. *Eastern Branch:* Wednesday, November 25, 7.30 p.m., Town Hall, Luton. Chairman's Address on "Industrial Gas Turbines," by Mr. H. Norman G. Allen. *Institution (Internal-Combustion Engine Group):* Friday, November 27, 5.30 p.m., Storey's-gate, St. James's Park, S.W.1. (i) "Fuel Systems and Controls for Marine Gas Turbines," by Mr. R. F. Darling; and (ii) "Main-Propulsion Gas-Turbine Set for Oil Tanker Auris," by Mr. B. E. G. Forsling. Automobile Division.—*Birmingham Centre:* Tuesday, November 24, 6.45 p.m., James Watt Memorial Institute, Birmingham. "An Economical Automobile Gearbox," by Mr. T. C. F. Stott. *Western Centre:* Thursday, November 26, 6.45 p.m., Grand Hotel, Bristol. "Commercial Vehicle Problems," by Mr. G. H. Lee.

Institute of British Foundrymen.—*Birmingham Branch:* Wednesday, November 25, 7.15 p.m., James Watt Memorial Institute, Birmingham. "Shell Moulding," by Mr. J. E. Worthington.

Institution of Structural Engineers.—Thursday, November 26, 6 p.m., 11, Upper Belgrave-street, S.W.1. "Reconstruction of a Soaking Pit Building," by Mr. H. C. Husband and Mr. K. H. Best. *Midland Counties Branch:* Friday, November 27, 6 p.m., James Watt Memorial Institute, Birmingham. "Space Frames and Skin Structures," by Mr. F. J. Samuely.

Television Society.—Thursday, November 26, 7 p.m, Cinematograph Exhibitors' Association, 164, Shaftesbury-avenue, W.C.2. Discussion on "Television Converters."

Incorporated Plant Engineers.—*Sheffield Branch:* Thursday, November 26, 7.30 p.m., Grand Hotel, Sheffield. "Oil Injection Method of Separating and Uniting Joints on Shaft Couplings," by Mr. G. D. Jordan.

Institution of Engineering Inspection.—*North-Western Branch:* Thursday, November 26, 7.30 p.m., Engineers' Club, Manchester. Discussion on "Humorous Aspects of Inspection," opened by Mr. D. Avison.

North East Coast Institution of Engineers and Shipbuilders.—Friday, November 27, 6.15 p.m., Mining Institute, Newcastle-upon-Tyne. "Experience During Last Ten Years in the Design of Marine Boilers," by Mr. R. L. J. Hayden.

Manchester Association of Engineers.—Friday, November 27, 6.45 p.m., Engineers' Club, Manchester, "Fluid Couplings," by Mr. E. C. Farrer.

Institution of Engineers and Shipbuilders in Scotland.—Friday, November 27, 7.45 p.m., Robert Gordon's Technical College, Aberdeen. "Conveyors for Handling of Materials in Bulk," by Mr. J. Findlay.

PERSONAL.

H.R.H. The Duke of Edinburgh, K.G., has been elected an honorary member of the Royal Institution of Chartered Surveyors, 12, Great George-street, London, S.W.1.

Sir John Lennard-Jones, K.B.E., F.R.S., has been awarded the Davy Medal of the Royal Society for his work on the applications of quantum mechanics to the theory of valency and to the analysis of the intimate structure of chemical compounds. The Hughes Medal of the Society has been awarded to Sir Edward Bullard, F.R.S., for his contributions to the development of the physics of the earth.

Mr. J. Arnold Rowland, assistant production manager of William Jessop and Sons Ltd., Sheffield, has been made planning, production, control and progress manager of the Low Moor Alloy Steel Works Ltd., Bradford.

Mr. Walter Harding has been nominated President of the Institution of Heating and Ventilating Engineers for 1954-55, in succession to Mr. F. R. L. White.

Mr. T. Eustace Smith, T.D., M.Inst.N.A., has been elected President of the Shipbuilding Employers' Federation, 1, Chester-street, London, S.W.1, for the coming year, in succession to Mr. J. G. Stephen, M.C., M.Inst.N.A., M.I.E.S. Mr. C. A. Winn, M.Inst.N.A., becomes senior vice-president and Mr. Horace Willson, M.Inst.N.A., M.I.E.S., and Mr. E. J. Hunter, M.Inst.N.A., M.I.Mar.E., vice-presidents. Mr. R. C. Thompson, C.B.E., M.A., M.Inst.N.A., has been elected chairman and Mr. Henry Robb, M.Inst.N.A., M.I.E.S., vice-chairman, of the Conference and Works Board.

Mr. H. McNeil, director and general manager, Babcock and Wilcox, Ltd., Babcock House, Farringdon-street, London, E.C.4, has been appointed deputy managing director. Mr. J. Stewart Robertson, assistant general manager, is to be general manager.

Mr. W. C. Bell, of Stewarts and Lloyds Ltd., has been awarded the American Iron and Steel Institute Medal for 1953 for his paper, "A Review of European Operating and Technical Practices," delivered in New York on May 27, 1953. Instituted in 1927, this is the first time that the Medal has been awarded to a representative of the British steel industry.

Mr. P. Rhodes is retiring from the position of London area manager on December 31 after 32 years of service with the Hoffmann Manufacturing Co. Ltd., Chelmsford, Essex. His successor is Mr. S. G. M. Shallard, M.B.E., A.M.I.Mech.E., hitherto deputy London area manager.

Mr. R. Gore, A.M.I.Mech.E., A.M.I.P.E., has been appointed methods engineer to Sheepbridge Engineering Ltd., Chesterfield, Derbyshire, and will take over all problems relating to production control, material handling, factory layout and general process planning.

The sales of B.S.A. broaches has been transferred from Sparkbrook, Birmingham, to Burton, Griffiths & Co. Ltd., broach division, Studley-road, Redditch, Worcestershire. Mr. J. R. P. Davies has been appointed sales manager of the broach division.

Mr. N. Blakstad has been appointed representative in Europe of the B.S.A. Tools Group of Companies.

Scientists and Technologists Engineering Partnership Ltd. (STEP Ltd.), Abbey House, Victoria-street, London, S.W.1, a new project group headed by Mr. J. S. Smith, industrial designer, and Dr. B. J. Zaczek, D.I.C., Dipl. Ing., A.M.I.Mech.E., heat-transfer engineer, will specialise in heat-using appliances.

The Fairmile Holding Co. Ltd., 28, Victoria-street, London, S.W.1, which have hitherto traded independently, have now been merged with the Fairmile Construction Co. Ltd., Cobham, Surrey, which have acquired the goodwill and assets. Outstanding contracts will be supervised by Mr. L. A. Cushman, director of the former company, who will continue his association with the Fairmile organisation.

The Gearmark Co., who undertake machine-shop work, light assemblies and draughting work, have left their premises at Green Street Green and have concentrated their office, machine shop and stores at Farnborough-way, Farnborough, Kent. The chief engineer is Mr. J. M. Tebby, A.M.I.Mech.E., M.J.I.E.

Radio-Controlled Fuelling Vehicles for London Airport.—Four of the largest of the fuelling fleet of Shell-Mex and B.P. Ltd., Shell-Mex House, Strand, London, W.C.2, in service at London Airport, have been equipped with radio telephones so that their movements can be directed from a central control room in the Shell-Mex and B.P. office, thus eliminating return journeys to base for fresh instructions, and saving time and mileage. The control room is linked directly with British Overseas Airways Corporation and British European Airways; other air lines order their supplies by telephone.

EXHIBITS AT THE BUILDING EXHIBITION.

(*For Description, see Page* 652.)

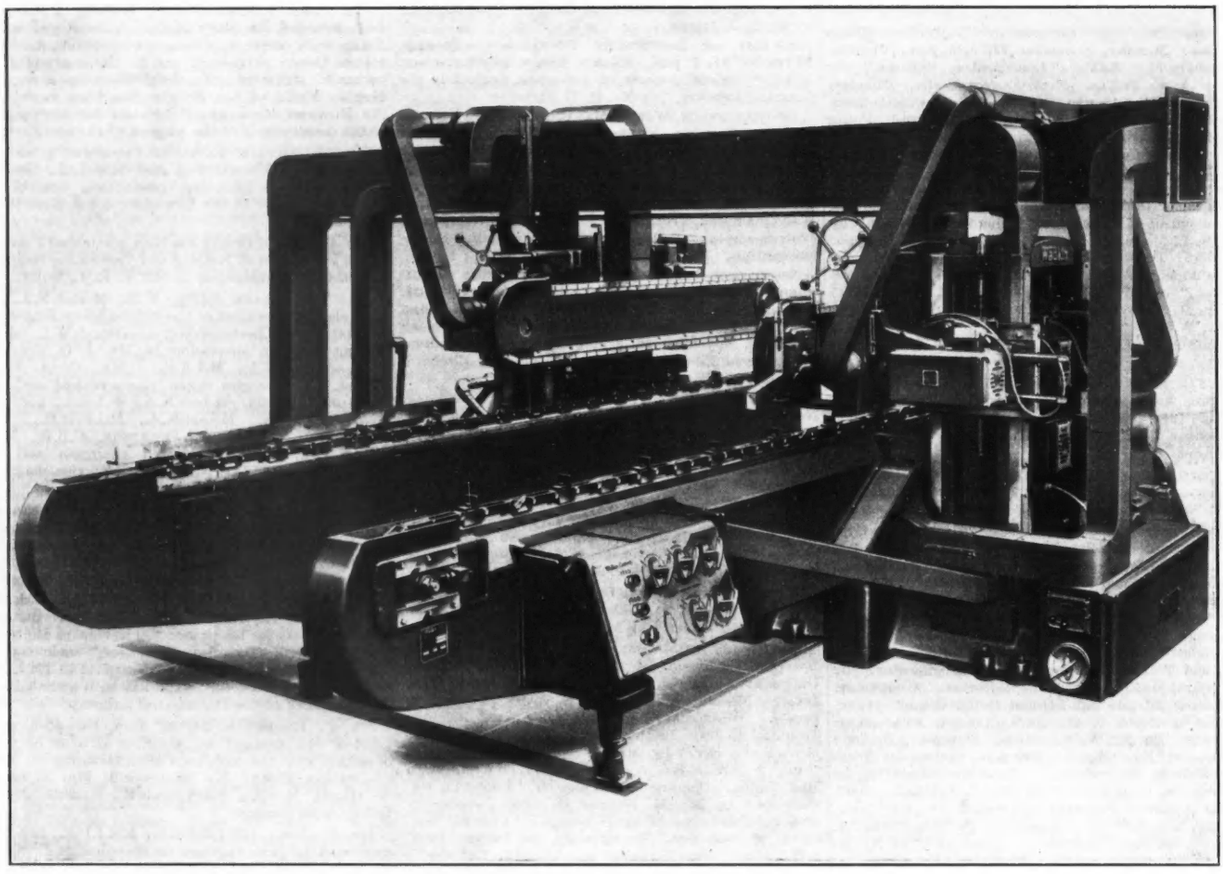


Fig. 5. Double-Ended Tenoning Machine; Wadkin, Ltd.

Fig. 6. 24-in. Panel Planer; Wadkin, Ltd.

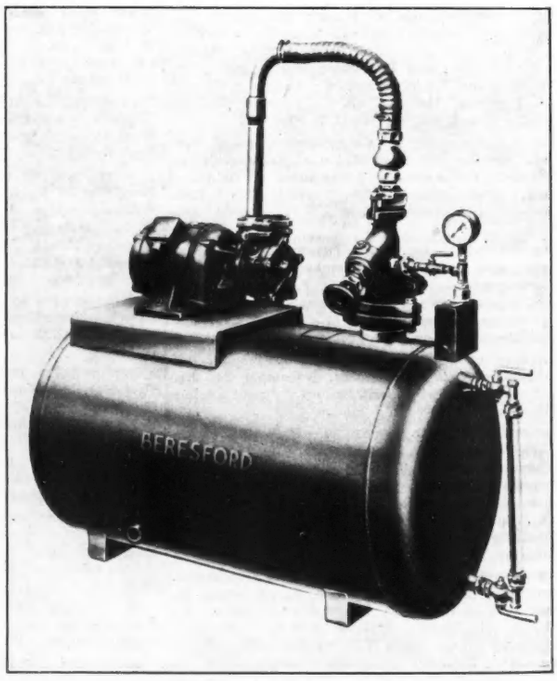


Fig. 7. Pressure Water Unit; James Beresford & Son, Ltd.

ENGINEERING

35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.2.

Registered at the General Post Office as a Newspaper.

We desire to call the attention of our readers to the fact that the above is the address of our Registered Offices, and that no connection exists between this Journal and any other publication bearing a similar title.

Telegraphic Address:

ENGINEERING, LESQUARE, LONDON.

Telephone Numbers:

TEMPLE BAR 3663 and 3664.

All editorial correspondence should be addressed to the Editor and all other correspondence to the Manager.

Accounts are payable to ENGINEERING Ltd. Cheques should be crossed "The National Provincial Bank, Limited, Charing Cross Branch." Post Office Orders should be made payable at Bedford Street, Strand, W.C.2.

SUBSCRIPTIONS.

ENGINEERING may be ordered from any newsagent in town or country and from railway bookstalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months, payable in advance:—

For the United Kingdom and all places abroad, with the exception of Canada	£5 10 0
For Canada	£5 5 0

Subscriptions for periods less than twelve months are based on the price of a single copy, namely, 2*s.* 3*d.* post free.

ADVERTISEMENT RATES.

Terms for displayed advertisements can be obtained on application to the Manager. The pages are 12 in. deep and 9 in. wide, divisible into four columns 2¼ in. wide. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

The charge for advertisements classified under the headings of "Appointments Open," "Situations Wanted," "Tenders," etc., is 10*s.* for the first four lines or under, and 2*s.* 6*d.* per line up to one inch. The line averages six words and when an advertisement measures an inch or more, the charge is 30*s.* per inch. If use is made of a box number the extra charge is 1*s.* per insertion, with the exception of advertisements appearing under "Situations Wanted." Series discounts for all classified advertisements can be obtained at the following rates:—5 per cent. for six; 12½ per cent. for thirteen; 25 per cent. for twenty-six; and 33⅓ per cent. for fifty-two insertions.

TIME FOR RECEIPT OF ADVERTISEMENTS.

Classified advertisements intended for insertion in the current week's issue must be received not later than first post Monday.

"Copy" instructions and alterations to standing advertisements for display announcements must be received 16 days previous to the date of publication, otherwise it may be impossible to submit proofs for approval.

The Proprietors will not hold themselves responsible for advertisers' blocks left in their possession for more than two years.

CONTENTS.

	PAGE
The Mining Machinery of the Atlas Diesel Company (*Illus.*)	641
Literature.—Luminescence and the Scintillation Counter. Circuit Breaking: Researches by the British Electrical and Allied Industries Research Association. Introduction to the Foundations of Mathematics	644
Diffusion of Load into the Decks of Plate-Girder Bridges (*Illus.*)	645
Photo-Electric Protection of High-Voltage Equipment	648
Self-Erecting Building Cranes (*Illus.*)	648
Conference on Cathodic Protection	650
625-h.p. Diesel-Hydraulic Locomotives (*Illus.*)	651
The Building Exhibition at Olympia (*Illus.*)	652
The "Princess" Flying Boat	653
Notes from the Industrial Centres	654
Notices of Meetings	655
Personal	655
The Atomic Energy Project	657
British Consulting Engineers	658
Notes	659
Hydro-Electric Developments in Portugal (*Illus.*)	660
Production of Two-Stroke Oil Engine for Automobiles (*Illus.*)	663
The First Five Years of Nationalised Electricity Supply	663
Electronic Chiming Installation for Tower Clock	664
Labour Notes	664
The Isodynamometer (*Illus.*)	665
Prestressed-Concrete Office Building	667
Applications of Small Gas Turbines	668
Light Maintenance Grader (*Illus.*)	668
Contracts	669
Controlling Side-Register in Reeling Sheet Material (*Illus.*)	669
Launches and Trial Trips	670
Trade Publications	670
Plunger Pressure Gauge (*Illus.*)	670
Extinguishing Oil Fires by Fog Nozzles (*Illus.*)	671
Relay for Control of Reactive Power	671
Notes on New Books	672
System for Remote Indication of Measurements (*Illus.*)	672
Books Received	672

PLATES.

Plates XXXIV and XXXV.—THE MINING MACHINERY OF THE ATLAS DIESEL COMPANY, STOCKHOLM.

ENGINEERING

FRIDAY, NOVEMBER 20, 1953.

VOL. 176. No. 4582.

THE ATOMIC ENERGY PROJECT.

A WHITE PAPER,* presented by the Government to Parliament last week, describes a plan whereby it is hoped that the knowledge already acquired in the use of atomic energy will be increased; and, what is more important, applied to purposes which will be of advantage to the nation in other than purely military fields. The underlying reason for the changes foreshadowed in this document are that development in this branch of science has reached a stage when the nature of the controlling organisation must be altered; and although it may be admitted that in principle a good case has been made out for such a change, time alone can show whether the potentialities of this new great force of nature can be fully exploited in the way suggested. The problem is not rendered easier by the fact that atomic energy was first used for military purposes and that those purposes will unfortunately continue to occupy a leading place among its future applications. The result, as far as this country is concerned, has been, as is well known, that a good deal of fundamental work has been conducted elsewhere; and that we still do not possess all the knowledge that we might have acquired had not certain, perhaps necessary, restrictions been imposed on the grounds of security. Moreover, when war ended large industrial concerns in this country, which might in other circumstances have been able and willing to undertake major tasks in the field of atomic energy, found that their resources were fully committed to the task of re-conversion to peace-time production, in order to meet the over-riding need for the rebuilding of our exports.

It is, therefore, greatly to the credit of all concerned that during the past eight years so much progress has been made in this country not only in the military field (the results of which, although rightly still mainly kept secret, received some publicity a year ago at Monte Bello) but in medicine and biology and still more in possible industrial applications. In the latter branch, as Sir Christopher Hinton recently pointed out, the developments that have taken place have been most satisfactory considering the difficulties, which although necessarily great, are, it is becoming clear, not insuperable. In fact, what has been done gives rise to some hope that a method may soon be found whereby the problem raised by our diminishing supplies of easily worked coal will be solved.

It is in the light of these conditions that the changes suggested in the White Paper must be examined. During the war, work on atomic energy was entrusted to a special directorate under the Department of Scientific and Industrial Research. In 1945, however, it was decided that the complicated and costly establishments which would be required for further research and development should be the responsibility of the Ministry of Supply, a body which had, to quote the White Paper, "at its disposal a wide range of facilities and resources and much war-time experience of quasi-industrial problems." For some years the keynote of the work that was carried out was research. As time went on, however, the importance both of weapons production and industrial applications increased; and as a result, atomic energy was marked out as something exceptional in the range of departmental activities. A turning point, indeed, seems to have been reached when it was realised that to investigate fully whether it was possible to utilise atomic energy for the production of power "the development of many kinds of research, physical, chemical, metallurgical and engineering" would not only be necessary, but would need all the imagination and drive we, as a nation, could provide and would, above all, call for flexibility and rapidity of decision in dealing with the various problems encountered. Moreover, as the industrial uses of atomic energy become of relatively greater prominence the case for a form of control which is more akin to the structure of a big industrial organisation than to that of a Government department is increased and will, in the Government's view, become even stronger as the need for closer contact and more co-operation with industry and the application of atomic techniques become greater.

It has, therefore, been decided that the most rapid and economical development can be secured by transferring responsibility for work on atomic energy from the Ministry of Supply to a non-departmental organisation, which will be run on industrial lines and have no responsibility outside its own field. As, however, such a body would differ from any other now in existence, owing to the need for close control of policy and the necessary dependence on public funds, a committee was appointed, under the chairmanship of Lord Waverley, to consider its organisation in detail. This committee has made a number of suggestions, which appear as an appendix to the White Paper. The most important of these is that an Atomic Energy Corporation with an Executive Board

* *The Future Organisation of the United Kingdom Atomic Energy Project.* London: H.M. Stationery Office. [Price 6*d.* net].

should be formed and that the responsibility for the establishments controlled by the Atomic Energy Research Establishment, by the Production Division, and by the Atomic Weapons Research Establishment should be transferred to this body. The Ministry of Supply should, however, continue to be responsible for the conventional components of atomic weapons. A Minister of high Cabinet rank, who will be responsible to Parliament for the finances of the Corporation and for policy directions, should be designated, his main task being to ensure the efficiency of the Corporation as a whole and the maintenance of a balance between the use of atomic energy for defence, for power and for biological purposes. This Minister should also be chairman of a committee on which all departments concerned with the various aspects of atomic energy would be represented.

All these recommendations and a number of others of a consequential nature, which need not be dealt with here, have been accepted by the Government. In fact, a Bill is to be introduced to provide for the setting up of the Corporation and the Lord President of the Council has been designated as the Minister responsible for its activities, thus reverting in part to an earlier arrangement under which atomic research came under the Department of Scientific and Industrial Research. The Minister of Supply will, however, still be responsible to the Services for the provision of complete atomic weapons. It is also stressed that overall policy will remain in the hands of the Government and that, while the Corporation will have freedom in the day-to-day management of its affairs, including finance, its operations will be governed by directives which will lay down its objectives and determine its policy. When the Bill has been passed, Sir Edwin Plowden will be appointed the first chairman of the new Corporation and in the meantime will assist the Lord President in the work incidental to the establishment of the organisation. As chairman of the board of the new Corporation, Sir Edwin will discharge the functions of a general manager and will be assisted in these duties by four whole-time functional directors; one for weapons, one for research, and one for administration and finance. In addition, there will be two part-time directors.

An important omission in the proposals, which may perhaps be involuntary, is that while the relations between the Government and the new Corporation are fully discussed, almost the only reference to the relations of the latter with industry is one in which the need for closer contact and co-operation is stressed in general terms. This may mean much or little, but since, at least as far as the application of atomic energy to the generation of power is concerned, it will be necessary to tear away the veil of secrecy which has hitherto surrounded much of the work, it should be one of the first tasks of the new body to clarify this question, and to decide exactly what part private enterprise, and the electricity-supply industry, is to play in research, development and the manufacture of plant and fissile materials.

At this stage it is a little difficult to make further comment either favourable or unfavourable on these proposals. This much may, however, be said. The new body bears little resemblance to an industrial organisation, since the important task of providing atomic weapons is not and cannot be its sole responsibility. Neither can this task be entirely divorced from the industrial uses of atomic energy, since much of the knowledge gained in either application will necessarily be interchangeable. It is to be hoped, however, although this unfortunately cannot be guaranteed, that work on military applications will gradually become of less relative importance than that on industrial uses and that the large sums of money which must necessarily be spent on the development of the latter will bring in a rich harvest without any counteracting disadvantages.

BRITISH CONSULTING ENGINEERS.

THE right of a chartered engineer—civil, mechanical or electrical—to regard himself as a member of a profession was challenged in a recent book (*Professional People*, by Roy Lewis and Angus Maude). The authors argued (if memory is not at fault) that only those groups in society which imposed a certain ethical standard on their members were justified in calling themselves professions. Qualifying examinations, it was contended, were not enough. The argument was not convincing; indeed, it seemed as though the authors would admit to the select professional circle only those groups which have an ancient and honoured tradition allied with a "closed-shop" principle. Engineers may or may not be held in general honour—of that it is hardly for them to judge—but they certainly cannot claim as ancient a tradition as doctors or lawyers, if the granting of a Royal Charter is regarded as the beginning of their official establishment, and in this country the idea of a closed shop is not generally regarded with favour. Most of them, however, would probably be prepared to rally to the defence of consulting engineers, who are now intent on preserving those very principles and ethics which must surely be accepted as the hall-mark of a profession.

It should be known throughout the world, and especially in those undeveloped countries where, in the future, the services of consulting engineers are going to be most needed, that British consulting engineers have developed a professional code which is unequalled by the engineers of any other country. To the client, that code ensures unbiased and honest advice of the highest technical standard, and, in the last analysis, it ensures true economy in the execution of the contract for the constructional or other engineering work. The Association of Consulting Engineers, who celebrated their 40th anniversary with a luncheon in London last week, hold that the first duty of the consulting engineer is to safeguard the interest of the client and to ensure sound engineering work at minimum cost. They define a consulting engineer as a person possessing the necessary qualifications to practise in one or more of the various branches of engineering, who devotes himself to advising the public on engineering matters, or to designing and supervising the construction of engineering works, and for such purposes occupies and employs his own office and staff either solely or in conjunction with another consulting engineer, and is not directly or indirectly concerned or interested in commercial or manufacturing interests such as would tend to influence his exercise of independent professional judgment in the matters upon which he advises.

It is primarily because he is independent of "commercial or manufacturing interests" that the British consulting engineer claims some superiority over, for example, his American counterpart, who is at liberty to advertise his services. His independence of commercial interests is held to be a powerful advantage, of great significance to the client. When a design is being worked out by engineers they alone are qualified to judge the relative merits of different solutions, because they alone are in full possession of the relevant facts. Even another engineer of the same professional standing would hesitate to criticise the chosen solution without first going through the same process of calculation and assessment that had already been found necessary. In these circumstances, therefore, the client is not able to judge the merits and finer points of the consultant's proposals. He depends on the consultant for honest professional advice, and that is why he stands to gain by employing one who is a member of the Association of Consulting Engineers.

The professional conduct of the members is regulated by the rules of the Association, which provide a basis for agreement between the consulting engineer and his client. He must act strictly in a fiduciary capacity. He must not accept any trade commission, indirect profit, etc. He must place orders explicitly on behalf of his client and not on his own behalf, and he must not advertise directly or indirectly for professional employment. Acceptance of these rules has been found to ensure the confidence of both the contractor and the client in the consulting engineer. Unfortunately, the advantages of this type of client-consultant-contractor relationship are not fully appreciated abroad. In some countries there is a tendency to favour the American method, in which the connection between the consultant and the contractor is more direct. At the anniversary luncheon last week, Sir Bruce White announced that talks were in progress between the consultants and the Export Group for the Constructional Industries with the object of agreeing to a method of working which would enable the consulting engineer and the contractor to work together and put in a combined bid for work abroad in those cases where the clients preferred bids of this kind to be submitted. This would not contravene the ethics of their professon, and they were determined to safeguard their integrity and the impartiality of their advice, but he believed the scheme could be worked out satisfactorily. They had to face the fact that some clients preferred an arrangement of this kind.

A practicable outcome of these discussions will clearly enhance the power of British consulting engineers to continue to undertake major constructional works throughout the world. Their past achievements are eloquent testimony to their abilities. A booklet produced for the anniversary luncheon illustrated some of them: the Mersey Tunnel (the longest subaqueous tunnel in the world); the Howrah Bridge at Calcutta, which carries 44 million pedestrians and 10 million vehicles every year; the radio telescope, 250 ft. in diameter, which is being constructed for the Department of Scientific and Industrial Research; the Captain Cook graving dock at Sydney—the largest in the Far East; the Owen Falls hydro-electric scheme, which will develop 600 million kWh per annum; the Colne Valley sewerage plant, which serves more than half a million people; Mulberry Harbour—the historic invasion harbour towed in sections to the shores of Normandy in 1944; the Brabazon assembly hall—the largest steel-framed assembly hangar in the world; and the Otto Beit Bridge in Rhodesia, which is the longest suspension bridge in Africa.

These works, and many others, have established the world-wide reputation of British consulting engineers. Mr. Reginald Maudling, M.P., Economic Secretary to the Treasury, who spoke at the luncheon, said that in India and Pakistan, which he had recently visited, he was impressed by evidence of their high reputation. He stressed the fact that their work can so often lead to a welcome flow of orders to British industries. He said that they could, as a result of their services abroad, stimulate exports, and although he would hesitate to suggest to the Association what steps they might take to develop these possibilities, he hoped that they would be able to do something without their professional integrity suffering. Sir Bruce White was able to respond to this suggestion by expressing the hope that the agreement between the contractors and the consulting engineers would shortly be reached. He hoped that some countries would realise that the established British way was still the best, but, for those who did not, the proposed arrangements were being designed to meet their requirements. Not every contract, of course, requires the services of a consultant, but, where they are required, British consulting engineers have unexampled experience and an admirable code of practice.

NOTES.

COMMERCIAL TELEVISION.

The Government proposals for the introduction of commercial television, about which there has been so much speculation and controversy, contain little of technical interest. The Government White Paper entitled *Memorandum on Television Policy* (Cmd. 4005, price 4*d*.), was published at the end of last week. As a "basic principle" there is to be no sponsoring in the sense that that term is understood elsewhere. Instead, a new public Corporation, which will be responsible to Parliament through the Postmaster-General, is to be formed and will operate transmitting stations. It will not, however, produce programmes itself, but will hire out "time" to private companies, who will in turn sell some of it to advertisers. To perform these duties, which are surrounded by many difficulties—commercial, economic, political, religious and others—it is proposed that the commercial television service should be allotted two channels in what is known as Band III (174 to 216 megacycles). It is probable that at first the service would be given from not more than three stations and that if these are powerful enough some 45 to 50 per cent. of the country's potential audience will be reached. Four or five stations may, however, eventually be accommodated, if they are geographically well spaced, while further channels may become available not only in Band III, but in Band IV (470 to 585 megacycles) and Band V (610 to 960 megacycles). The Government feel that the combination of effective control on the one hand and greater freedom on the other, as proposed in the memorandum, "is not only a typically British approach to this new freedom but is one which will commend itself . . . to the majority of people in this country." It is perhaps hardly necessary to add that this opinion is not universally held.

THE BRITISH ELECTRICAL AND ALLIED MANUFACTURERS ASSOCIATION.

The annual dinner of the British Electrical and Allied Manufacturers Association was held at Grosvenor House, London, W.1, on Monday, November 16, the President (Sir Harry Railing) being in the chair. About 1,100 members and guests were present. Proposing the toast of "The Electrical Industry," the Minister of Supply (the Rt. Hon. Duncan Sandys) said that it was of vital importance to the country not only for the amenities it provided, but also for the part it played in the export trade. It was to be given an ever-widening opportunity of showing its enterprise, especially in connection with the work of the Atomic Energy Commission, and he was sure that this challenge would be successfully met in view of the almost insatiable demand for electric power. In reply, the President said that as the result of close co-operative action an industry had been built up which had broken our dependency on foreign supplies, which held its own in research and whose products were unsurpassed in quality. All this had been done by voluntary effort, and in view of these achievements they could smile when they were challenged on the price of one selected article among thousands. This vast industry had been erected with an eye to the whole edifice and they asked to be judged by the overall results over the years under ever-changing conditions. They were proud to have been responsible for this commonwealth of industries without which the country and the Commonwealth would have fared badly, both in peace and in two world wars. The toast of "Our Guests" was proposed by Mr. D. D. Walker, who said that they were glad to have the opportunity of cementing the relationship with other trade associations. These bodies had a great part to play and the more they co-operated the more valuable would be their contributions to industry. The Vice-Chancellor of the University of Cambridge (the Rt. Hon. H. V. Willink), in reply, referred to the fact that the generosity of the Association had made it possible to establish a chair of electrical engineering. This showed how well the importance of universities in national life was recognised.

RUSSIAN BOOK ON CATHODIC PROTECTION.

The fundamentals and operation of the cathodic protection of buried pipelines, storage tanks, and marine and other structures are fairly well known to engineers in this country and increasing attention is being devoted to this method of combating corrosion. The conference with which we deal on page 650 of this issue is evidence of the importance attached to cathodic protection in many sections of industry. The interest shown in the method, no doubt, was one of the reasons which have prompted the Department of Scientific and Industrial Research to put in hand the translation of a book originally published in 1950 by the chief petroleum marketing organisation of the Russian Ministry of the Petroleum Industry. The book, by Mr. V. A. Pritula and entitled *Cathodic Protection of Pipelines and Storage Tanks*, is now obtainable, price 10*s*. net, or, by post, 10*s*. 6*d*., from H.M. Stationery Office. It deals with the theory of the subject but provides also practical details on the method of carrying out this type of protection. Particular attention is devoted to the methods of calculation required for various types of installations; in fact, throughout the work, considerable emphasis is laid on the mathematical side of the problem. There are 160 pages and twelve chapters in the book and these deal with such matters as basic data for the design of a cathodic protection installation, calculations for the cathodic protection of a pipeline section, anodic earthing, current sources for cathodic protection systems, the design of a cathodic protection installation, protection by galvanic anodes, cathodic protection of oil-storage installations, and economics of cathodic protection. In a bibliography are given 25 references, all, with one possible exception, to Russian research work. Nevertheless the author deals with his subject in a general way, as a scientist, and his outlook is reasonably wide. It can therefore be recommended as a practical manual as well as a textbook.

AIR POLLUTION IN LONDON.

In March, 1953, the London County Council decided to ask the Government to inquire into the causes of atmospheric pollution in the area under their control and, presumably as a result, a Committee was set up, under the chairmanship of Sir Hugh Beaver, "to examine the nature, causes and effects of air pollution and the efficacy of present preventive measures" as well as "to consider what further preventive measures are practicable." The Rivers and Drainage Committee of the Council has now prepared a long "statement of evidence" which is to be submitted to this Committee and, in doing so, makes a number of suggestions about the ways in which action is desirable. Among these, it is proposed that the Government should do everything possible to ensure that ample supplies of smokeless fuel are made available at a competitive price and that more extensive cleaning should be carried out at the pits. Consideration should also be given to the prescription of a minimum degree of efficiency of grit arresters, to making it compulsory for the maximum permissible amount of grit per cubic foot of flue-gas emitted from chimneys of large-scale fuel-burning equipment to be specified, and to the practicability of laying down a standard of measurement of smoke. In addition, it is recommended that an investigation should be carried out into the effect of high chimneys on the dispersal of sulphur compounds in flue gases and the concentration of sulphur oxides in the neighbourhood of large power stations; that a full-scale test should be made of the flue-gas washing plant developed at the Fuel Research Station; and that the question whether flue-gas washing should be made obligatory at all electricity generating stations in populous areas should be determined. It is also suggested that investigations should be made into methods by which smoke can be avoided when fires in railway engines are first lighted, into the practicability of using only Diesel locomotives for shunting and into the possibility of extending the electrification of railways. Moreover, steps should be taken to reduce smoke emissions when serious fog is forecast. Finally, amending legislation should be introduced requiring the approval of the administrating authority before industrial boiler plant is installed or modified; to render it possible to make by-laws requiring smokeless fuel to be burnt in open grates; to compel the use of grit arresters in all boiler plant consuming large quantities of fuel; and to enable smokeless zones to be established and expenditure to be incurred on publicity.

CYCLE AND MOTOR-CYCLE SHOW.

The 28th Cycle and Motor-Cycle Show at Earl's Court, London, was declared open on November 14 by the Rt. Hon. Anthony Eden, M.C., M.P. The show is organised by the British Cycle and Motor-Cycle Manufacturers and Traders Union, Limited, and this year there are 162 exhibitors. Facts given by Mr. H. N. Palin, the Director of the Union, showed that exports of cycles and motor-cycles had increased rapidly since the war and are now 33 times as large as they were in 1939. Hard-currency areas were taking a large share, particularly the United States, where cycling is gaining in popularity very rapidly. The cycles exhibited this year show a trend towards brighter colours and hard wearing finishes, though the gold-plated machine for an Indian enthusiast will probably remain unique. The popularity of the motor-attachment remains high, and there is at least one design on show. An all-British motor-scooter, the "Ascar," has been introduced this year, and there are more motor-cycles of the 250-c.c. class. There is a quiet emphasis throughout the show on accident-prevention and a road-safety booklet compiled by the Union will in future be supplied with every motor-cycle sold.

QUARRIES AND METALLIFEROUS MINES IN THE UNITED KINGDOM.

In this country, the output of minerals in 1951 amounted to 147,543,492 tons, including 11,009,800 tons of opencast coal and 191,400 tons of fireclay produced at opencast coal workings. The comparable figures for 1950 were, respectively, 136,946,589 tons, 12,185,400 tons and 38,150 tons. A substantial increase in the total output to a new high level, notwithstanding a reduction of 9 per cent. in the output from opencast coal quarries and a slight decline of 1¼ per cent. from 64,000 to 63,200 in the average number of persons employed, is noteworthy. It is pointed out, in the recently-published report of H.M. Inspectors of Mines and Quarries, for 1951, that the trend of mechanisation is clearly seen if the output and employment figures be compared with the position 24 years ago. Then, just over 60 million tons of minerals were produced and nearly 82,000 persons were employed, a yearly average of about 730 tons per person, compared with the present 2,330 tons. A good deal of the report is devoted to accidents and their causes, and the statistics given indicate that 62 persons were killed in 1951, a regrettable increase of 17 compared with the previous year, and 165 suffered reportable injuries, an increase of 8. The figures for 1951, however, included 13 deaths and 37 injuries suffered at opencast coal workings, that being the first full year since these workings became subject to quarry law. Falls of ground caused 20 deaths and 25 "reportable" injuries, and it is emphasised that some, at all events, of the lives lost might have been saved if safety helmets had been worn. One death and 31 injuries were caused by the use of explosives and five persons were killed and eight injured as a result of falling from paths, steps, ladders and galleries. Deaths from haulage and transport numbered 18, and 30 persons were reportably injured, five of the fatal and seven of the non-fatal accidents occurring at opencast coal workings. There was a large increase in accidents due to machinery, 11 persons being killed and 34 injured in 1951, against five and 19, respectively, in 1950. Several of these accidents were due to the removal of guards from machinery in motion. Finally, seven persons were killed and 37 injured in miscellaneous unspecified accidents. The report states that little headway has been made in inducing employees to wear protective clothing. The number of eye injuries sustained

continues to decrease, but most of those which did occur could have been prevented by the use of goggles.

THE JAMES WATT MONUMENT.

James Watt has always been an outstanding exception to the axiom that "a prophet is not without honour, save in his own country and his own house." He was a national figure and as such was bound to be commemorated, even without the zeal of his son, James Watt, jun., to ensure that it should be done as widely as possible. It was natural that Watt's birthplace, Greenock, should wish to do honour to his memory; they did so by purchasing from Sir Francis Chantrey, for the considerable sum of 2,000*l*., raised by public subscription, a replica of the fine statue which Chantrey had made for Watt's tomb in Handsworth parish church. To accommodate it in suitable surroundings, there was constructed the building known as the James Watt Monument, which has housed for nearly 120 years Greenock's subscription library of some 60,000 books, some of which were purchased with a gift of 100*l*. from James Watt himself. The expense of maintaining the building, throughout its life, has been the responsibility of the committee and members of the Greenock Library, who, on more than one occasion, have had to bear the cost of heavy repairs, necessitated by dry rot. They have no endowment to assist them, and post-war economic conditions make it increasingly difficult to finance the repairs that have again become necessary, while maintaining an adequate library service. Expert architectural advice was sought, and the conclusion reached that 25,000*l*. was the minimum required to safeguard the future of the building. An appeal has been launched, therefore, with the support of the Earl of Eglinton and Winton, the Rt. Hon. Hector McNeil, Member of Parliament for Greenock and formerly Secretary of State for Scotland, and Sir Hector Hetherington, Principal of Glasgow University. It is addressed "not merely to the citizens of Greenock, but to all those who have prospered by the inventions of James Watt, and to all who care for the great tradition of precise engineering." Contributions should be addressed to Mr. George Morrison, the chairman of the Appeal Fund Committee, c/o the Clydesdale and North of Scotland Bank, Limited, 134, Cathcart-street, Greenock.

YOUNG PERSONS IN INDUSTRY.

During recent years, employers have increasingly realised that the changing reactions of young people at different periods of their lives to one another and to adults should be the subject of careful study, but, at the present time, little appears to be known concerning the nature of the education which should be provided during adolescence to help juveniles to establish good human relationships later in life. The Department of Education of the University of Oxford is arranging a short conference on "The Young Worker: Education for Human Relations," which will be held at the University from Saturday, April 3, to Friday, April 9, 1954. It is hoped that this meeting will be the means of bringing together employers, managers, teachers, trade unionists, members of local education authorities, etc. Aspects of the problem to be dealt with during the conference will include the meaning of human relations in an industrial community, reasons for the importance of good human relations, responsibility for the establishment of good human relations, and the means of educating those responsible to play their parts most effectively. The needs of the young employee in his efforts to create satisfactory human relationships will receive special consideration. The conference, which is under the patronage of H.R.H. the Duke of Edinburgh, K.G., will be opened by Sir Hubert Houldsworth, chairman of the National Coal Board, and the principal speakers will include Mr. M. L. Jacks, director of the Department of Education of the University; Mr. Paul Cherrington, Warden of Urchfont Manor; and Mr. A. G. B. Owen, of Messrs. Rubery Owen and Company, Limited. Further particulars may be obtained from the secretary, Conference on the Young Worker, 15, Norham-gardens, Oxford.

HYDRO-ELECTRIC DEVELOPMENTS IN PORTUGAL.

In 1944 the Portuguese Government introduced legislation dealing with the electrification of the country, and thus rendered it possible to utilise fully the water power resources of the northern and central provinces. In the following year three companies were formed—the Hidro-Electrica do Zezere and the Hidro-Electrica do Cavado to handle the production of electrical energy, and the Companhia Nacional de Electricidade for transmitting the power to the main centres of demand.

In view of the importance of the work, the Portuguese Government participated substantially in the finance and administration of all three undertakings. At about the same time two British companies—the English Electric Export and Trading Company, Limited, and Metropolitan-Vickers Electrical Export Company, Limited, which became known as the British group, sent representatives to Portugal to confer with the engineers who had been appointed to study the various hydro-electric projects. This mission collected sufficient data to enable them, in 1945, to put forward proposals for harnessing the available water p wer. After further discussions the two Portuguese power companies placed contracts with the British group for the supply of mechanical, hydraulic and electrical equipment for the generating stations at Castelo do Bode on the River Zezere and at Vila Nova on the River Cavado. Later on a contract was also placed with the British group by the Companhia Nacional de Electricidade for a sub-station at Castelo do Bode, which is known as the Zezere Substation. More recently a contract has been placed with the same group for the power station plant and equipment at Cabril, which is also on the River Zezere.

In order to control the irregular flow of the Zezere, which is a tributary of the Tagus, it was decided to build four dams on it at Cabril, Bouca, Castelo do Bode and Constancia. It was also decided that a power station should be constructed at each of these points. The first of these dams to be built was that at Castelo do Bode, as it enables the largest water storage to be provided and at the same time the maximum regulation of the river flow to be obtained. The principal civil engineering works at Castelo do Bode consist of an arch dam with a maximum height of 377 ft. and a flood spillway designed to deal with a discharge of 144,790 cub. ft. per second. The maximum gross head is 312 ft. The dam is therefore one of the largest of its type in Europe, and the storage capacity of the reservoir, which is 37,787 million cub. ft., is only surpassed in the United States. The power station was designed to accommodate three generating units, with a total capacity of 186,000 h.p.

As regards the second scheme, the River Cavado flows into the sea about 30 miles north of Oporto, and about 40 miles from its mouth is joined by a tributary, the River Rabagao, across which a dam 308 ft. high has been built. The reservoir formed by this dam, which is known as Venda Nova, has a capacity of 3,249 million cub. ft. Water from this reservoir flows through a tunnel 6,408 ft. long and thence through a pipeline 2,832 ft. long and 8·53 ft. in diameter to the power station at Vila Nova, where it is discharged into the River Cavado. The maximum head is 1,362 ft. The power station is equipped with three generating units with a total capacity of 117,000 h.p. but provision has been made for the installation of a fourth set when another dam has been built on the River Cavado, up-stream of Vila Nova at Paradela. This dam will impound a reservoir with a capacity of 2,825 million cub. ft., whence a tunnel and pipeline will carry the water to the power station. The fourth set will bring the total capacity up to 156,000 h.p.

The hydro-electric station at Castelo do Bode was opened by the then President of the Portuguese Republic—Marshal Carmona—on January 21, 1951, and that at Vila Nova a few months later. These two stations are now in full commercial service, their total generating capacity being 268 MVA. The substations, including that at Zezere, which were constructed by the Companhia Nacional de Electricidade, were formally inaugurated by the then President—General Lopes—in July, 1952.

Castelo do Bode Power Station.

The power station at Castelo do Bode is constructed at the foot of the dam with the spillway and its radial-type gates at one side of the building, as shown in Fig. 1. Two scour culverts with a diameter of 3 m. are embedded in the structure, one on each side of the power station. These culverts are connected to English Electric disperser valves, each of which is capable of discharging 150 tons of water per second under a maximum head of 312 ft. The 4-m. penstocks for the main turbines, as well as those for the auxiliary machines, are also embedded in the structure, the former being connected to the turbine inlet valves. These valves, which were constructed by the English Electric Company, Limited, have a bore of 11 ft., and together with accessories weigh about 160 tons. Their bodies and doors were fabricated from mild steel, with forged-steel trunnions. They are controlled by the pressure of the water in the pipe-line and can be closed against the maximum flow. The addition of an upstream seal enables maintenance to be carried out on the normal service seal.

The machine hall, of which an illustration is given in Fig. 2, is of the single-floor type, so that all the plant is easily accessible and can be handled by one 260-ton crane, which was constructed by Sir William Arrol and Company, Limited, Glasgow. The auxiliary boards for each set are placed along the up-stream wall and the controls are all on one floor. Each of the three turbines, which were constructed by the English Electric Company, Limited, has a normal rating of 62,000 h.p. under the average head of 262 ft., and a maximum rating of 73,000 h.p. under the maximum head of 317 ft., when running at 214 r.p.m. The machines are of the vertical reaction type with plate-steel spiral castings. These were manufactured in four parts and were welded together and pressure tested on site. The runners to which the streamlined vanes are welded are of cast steel, the vanes themselves being protected by stainless steel. The turbine bearings have their own lubricating systems, which are operated by alternating-current motor-driven pumps. Direct-current motor-driven pumps have also been installed and can be used in the event of a failure in the alternating-current supply. The governor is of the automatic oil-pressure type, with an electrically-driven actuator pendulum, the motor for which is supplied from a special generator mounted on the main alternator shaft. A steel lining is provided for the draught-tube bends, and a steel support rigidly connects the generator to the turbine and transmits the loads, including those from the thrust bearing, through the speed ring to the foundations.

The alternators are two-bearing vertical-shaft machines with a rating of 57·4 MVA at 0·786 power factor. They generate three-phase current at 15·5 kV and 50 cycles. Mounted above the rotor are the governor generator and the main and pilot exciters. The alternators are self-ventilated with water-cooled air coolers, these being distributed round the stator frame and the whole being totally enclosed in sheet-steel air ducting. The sets are also designed to run as synchronous condensers with an output of 40 MVA at zero power factor (over-excited). For this purpose the water level in the draught tube has to be kept below the runner level at all tail-race levels. This is achieved by admitting compressed air to the draught tube from a large air receiver and special compressor. The stators were transported in quarters, which were jointed at site. The rotor was also transported in parts, which comprised the shaft and hub, with a combined weight of 70 tons, the rotor plates and the poles. The whole rotor, which weighs 240 tons, was balanced in position on the site. It has been designed to withstand a maximum runaway speed of 400 r.p.m.

There is a guide bearing below the rotor and a combined thrust and guide bearing above, a common lubricating system being provided which is supplied from pumps driven by alternating-current motors, with direct-current motor-driven pumps as standby. The thrust bearing, which takes the hydraulic

HYDRO-ELECTRIC DEVELOPMENTS IN PORTUGAL.

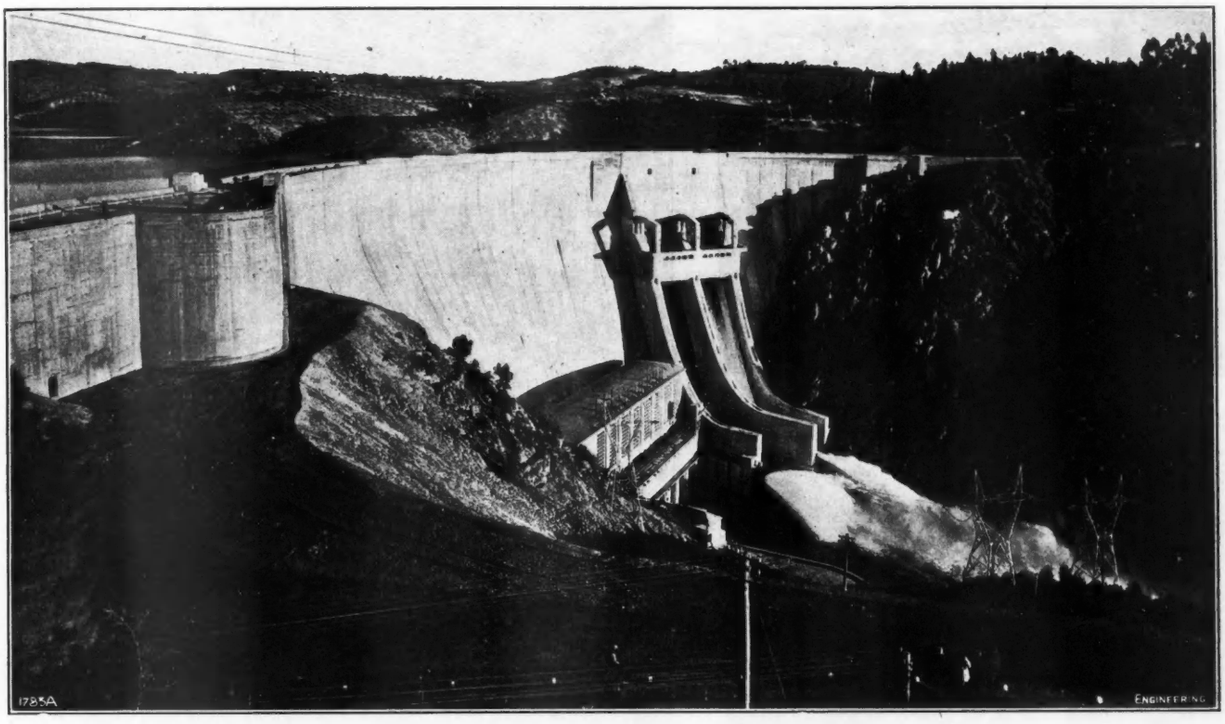


FIG. 1. CASTELO DO BODE POWER HOUSE AND DAM.

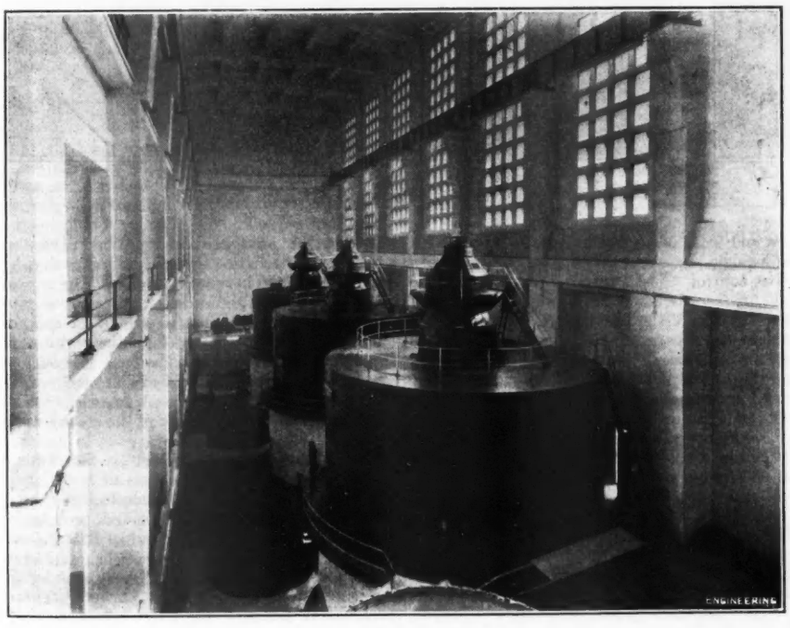


FIG. 2. CASTELO DO BODE MACHINE HALL.

thrust from the turbine as well as the weight of the rotating parts, is of the tilting-pad type. Air-operated brakes are provided to bring the set to rest quickly and to prevent damage to the thrust pads owing to the rotation of the rotor at very slow speeds. The brakes are also used to jack up the rotor for maintenance, high-pressure oil being employed for this purpose. The sets are protected against fire by carbon dioxide, which is automatically injected into the closed ventilation system when the circulating-current protection or an emergency switch operates.

All auxiliary services are supplied from two sets, each consisting of a horizontal reaction turbine and a 1,125-kVA 380-volt alternator running at 1,000 r.p.m., one of which is normally standby. These sets, which are installed in an annexe to the main hall, are automatically started up and shut down. In the event of failure of the low-tension supply from the set in service the standby is automatically started. The main transformers, which were made by the Metropolitan-Vickers Electrical Company, Limited, are located on a platform downstream of the machine. They are three-phase units rated at 52·5 MVA with a voltage ratio of 15·5 kV/165 kV at full load. The lower voltage windings are delta-connected and the high-voltage star-connected, with the neutral point solidly earthed. The 165-kV windings have $\pm$ 5 per cent. tappings which are connected to an externally-operated off-circuit tapping switch. The secondary voltage is maintained constant over the full load range by adjusting the generator voltage with an automatic regulator. The transformer losses are dissipated by forced oil circulation through water-cooled coolers. Each transformer weighs 120 tons.

The 15-kV connections between the alternators and transformers are of bare copper with a carrying capacity of 2,200 amperes, and are supported on porcelain insulators contained in concrete chambers. These chambers are connected by a set of three-phase 2,200-ampere transfer bars each of which is run in a concrete tunnel. A sheet-steel link cubicle in each generator-transformer circuit enables any machine to be connected through the transfer bars to a transformer other than its own in case of emergency or for maintenance, or to loading tanks for testing. The 165-kV overhead connections from the transformers are led to the substation and consist of stub lines about 820 yds. long. The generator breakers are at the substation, and are remote controlled from the power house. Surge diverters are connected to each generator circuit. The main and control cables and the overhead lines to the substation were manufactured by British Insulated Callender's Cables, Limited, Norfolk-street, London, W.C.2.

The auxiliary generators are remotely controlled by 2,400-ampere air-break circuit-breakers. These breakers are mounted on a board which also comprises a 'bus section switch and manually-operated 600-ampere air breakers for the heavier auxiliary circuits. The lighter circuits are fed through metal-enclosed fuse-switch units. The power station, the dam, the settlement and the substation are all supplied from this board. Each main generator-transformer unit also has its own essential auxiliaries board, which carries fuse-switches and latched-in contactors. These boards are fed by duplicate cables, one from each section of the

HYDRO-ELECTRIC DEVELOPMENTS IN PORTUGAL.

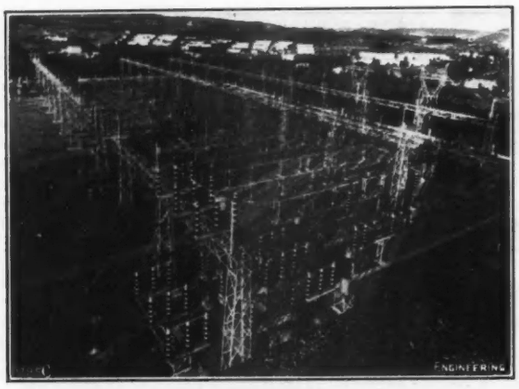


FIG. 3. OUTDOOR SWITCHGEAR AT ZEZERE SUBSTATION.

FIG. 4. EXTERIOR OF VILA NOVA POWER STATION.

FIG. 5. TURBINE HALL AT VILA NOVA.

main auxiliaries board. The control board is of the usual vertical sheet-steel cubicle type and is arranged on three sides of a rectangle with a desk in the centre. The equipment includes the automatic voltage regulators and synchronising and master frequency indicators. Ancillary equipment includes the batteries with charging gear at both the power house and substation, and an automatic telephone exchange. Water resistance loading tanks are provided for testing the generating sets, the three single-phase tanks having a total capacity of 57,400 kVA at 15,500 volts.

ZEZERE SUBSTATION.

The substation at Zezere, which is situated on a plateau some 800 yards from the power station, incorporates three 165-kV generator-transformer circuits belonging to the Hidro-Electrica do Zezere, as well as the 165-kV and 66-kV feeder circuits belonging to the Companhia Nacional de Electricidade. It forms the nodal point for controlling power from the River Zezere and from it current is transmitted to Lisbon through two 165-kV lines. Duplicate 'bus-bar switchgear is used for both the 165-kV and 66-kV circuits and, as will be seen from Fig. 3, is mounted on galvanised steel lattice structures with the 'bus-bars supported directly from the section isolators.

The switchgear, which was manufactured by the Metropolitan-Vickers Electrical Company, Limited, for both the 165-kV and 66-kV circuits embodies air-blast breakers. The 165-kV feeder breakers are equipped for a single high-speed reclosure with the "dead time" adjustable between 10 and 50 cycles. If a fault persists after a reclosure the breaker re-trips and locks out. Facilities are also provided for both single-phase and three-phase reclosure with selective control. The rupturing capacity of the 165-kV breakers is 2,500 MVA, and of the 66-kV breakers 1,000 MVA. The 165-kV coupler section equipment has a carrying capacity of 800 amperes but all the other breakers are rated at 600 amperes.

The compressor plant, all of which is in duplicate, is housed on the substation site and is designed for present and future requirements at 165 kV and 60 kV. The operation of the compressors is completely automatic. Initial compression and storage are at 650 lb. per square inch. In order to ensure the necessary dryness the air is expanded to half this pressure, at which it is stored in the pipelines and the breaker receivers. The current transformers for both the 165-kV and 66-kV circuits are mounted separately from the circuit-breakers. The transformers are of the wound type and are oil-immersed in a steel tank with porcelain primary bushings. The substation controls are housed in the switchyard, the board being of the vertical sheet-steel cubicle type without a desk, arranged on four sides of a square. Check synchronising is provided on all feeder circuits.

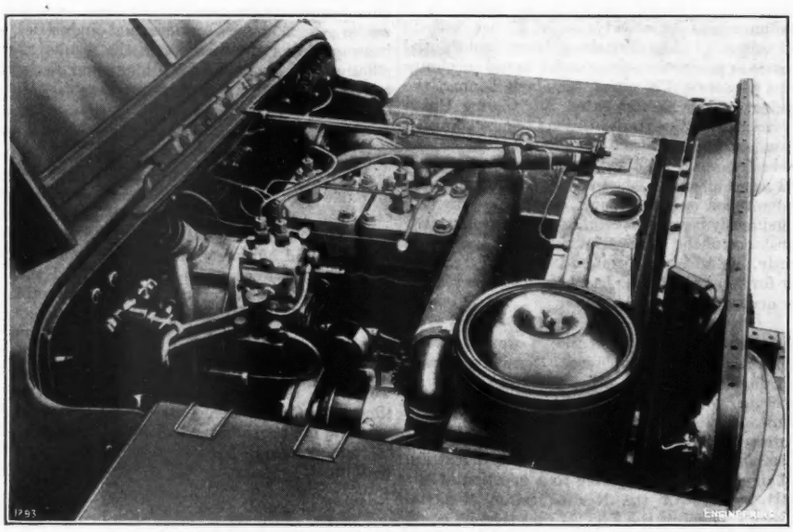
VILA NOVA POWER STATION.

As already mentioned, the Vila Nova power station is supplied from a reservoir at Venda Nova through a steel-lined tunnel and pipe-line. This pipe-line was constructed and erected by the South Durham Steel and Iron Company, Limited, and is 95 in. in diameter at the top, tapering to 83 in. at the bottom, while the steel varies in thickness from $\frac{5}{8}$ in. to 2 in. Entrance to it is controlled by a valve of the straight-flow type, the diameter of which is 7 ft. It is closed automatically by a paddle trip which is operated by excess water. The pipe-line itself terminates in distribution piping, which runs along the upstream side of the power house and is there connected to the turbine inlets through two straight-flow valves for each set. These valves have a bore of 32½ in. and, owing to the high head, have been constructed of cast steel. A general view of the exterior of the station appears in Fig. 4.

The generating plant, which is illustrated in Fig. 5, consists of three turbines of the horizontal impulse type, which were manufactured by the English Electric Company, Limited, and have an output of 36,000 h.p. at a head of 395 ft. and of 39,000 h.p. at 1,360 ft., the speed being 428 r.p m. Each set has four jets with twin stainless-steel runners cast integral with the buckets. The four inlet bends for each set have cast-steel nozzles, while the diffusers are of stainless steel and the spears have renewable points of the same material. Each set can be quickly brought to rest by applying a jet of braking water to the runner and is fitted with an automatic oil-pressure governor, the actuator of which is driven through gearing from the alternator shaft. The Metropolitan-Vickers alternators, which are rated at 32 MVA and generate three-phase current at 11 kV, have two bearings from which the turbine runners are overhung. The rotor is of the solid-disc type with T-shaped slots into which the poles are keyed. The rotating parts are designed to withstand a runaway speed of 793 r.p.m. and ventilation is on the closed-circuit system. A separate set, comprising a driving motor,

CAR WITH TWO-STROKE OIL ENGINE.

TURNER MANUFACTURING CO., LTD., WOLVERHAMPTON.



main and pilot exciters and flywheel, is provided for each alternator so as to smooth out the field forcing peaks and to supply stored energy to maintain the excitation should a fault occur in the motor circuit.

Each alternator is direct-connected to a group of three single-phase transformers which, like the alternators, are of Metropolitan-Vickers manufacture, the use of three-phase units having been precluded by transport difficulties. These connections are made by copper bars, in which links are inserted to enable any generator to be connected to any transformer or to a water resistance test tank. Each transformer unit is rated at 30 MVA and has a transformation ratio of 11/165 kV at full load. The secondary voltage is maintained constant by automatically regulating the generator voltage, as at Castelo do Bode. In addition to the main set the station contains an alternator driven by an impulse turbine for supplying auxiliary services. These services can also be supplied from the external 30-kV system through transformers, and those on the main sets through unit transformers. The station switchgear, which is of the air-blast type, is installed in stoneware cells and controls supplies from a neighbouring station at Ermal as well as local distribution.

The outdoor substation contains three alternator circuits, a 'bus coupler and the outgoing feeder to Oporto. A duplicate 'bus-bar construction has been adopted, with tubular conductors and interlocked off-load selectors, all of which are supported on post insulators and galvanised steel structures. The circuit-breakers, which are of the English Electric air-blast type, have a rupturing capacity of 2,500 MVA at 165 kV and, with the exception of that on the 'bus coupler, are equipped with oil-immersed porcelain-clad wound-primary current transformers. The feeder circuit-breaker is designed for single and three-phase high-speed single-shot auto-reclosure, with dead times adjustable between 15 and 60 and 10 and 20 cycles. The air for operation is stored at 600 lb. per square inch and supplied at 300 lb. per square inch. A supply is also provided from the compressor through reducing valves to the 30-kV switchgear. The main control board is similar to that at Castelo do Bode, but comprises an additional cubicle containing alarms and indicators for the valves on a mimic diagram, which can be closed in emergency from this position.

SMOKE PREVENTION.—The National Smoke Abatement Society has published two small booklets of extracts from last year's Ridley Committee's Report on National Fuel Policy, entitled respectively "Domestic Smoke Prevention and National Fuel Policy," and "Industrial Smoke Prevention and National Fuel Policy." Copies of the two booklets, price 6*d.* each, may be obtained from the Society at Chandos House, Buckingham Gate, London, S.W.1.

PRODUCTION OF A TWO-STROKE OIL ENGINE FOR AUTOMOBILES.

THE Turner Manufacturing Company, Limited, are now engaged at their Wulfruna Works, Villiers-street, Wolverhampton, in tooling-up for the large-scale production of a range of two-stroke oil engines designed for automotive and similar uses. The smallest engine of the three to be made—a two-cylinder unit with a bore and stroke of 92 mm. and 105 mm., respectively—was described by Professor S. J. Davies, together with tests he carried out on it, on pages 385 and 419, *ante*. This is one of the forms in which the engine will be made by the company. A larger engine, having three cylinders of the same dimensions in line, will also be marketed, and the range will be completed by two V engines with four and six cylinders, respectively. The principal details are given in the Table.

Model.	Cylinder bore and Stroke, mm.	Total Swept volume, litres.	Max. Speed (governed), r.p.m.	Max. b.h.p. at 2,800 r.p.m.	Max. torque, at 1,900 r.p.m., lb. ft.	Weight, lb.
2L (two-cylinder)	92 by 105	1·4	3,150	36	76	340
3L (three-cylinder)	92 by 105	2·1	3,150	54	114	450
4LV (four-cylinder)	92 by 105	2·8	3,150	72	152	560
6LV (six-cylinder)	92 by 105	4·2	3,150	120	230	720

The Turner Manufacturing Company have the world manufacturing and distribution rights, and propose marketing the engine for installation in all types of private, utility and commercial vehicle, including private cars and taxi-cabs. It will also be available for driving various types of agricultural and industrial machinery, and for stationary power purposes. Engines have been fitted to road vehicles—a 12-h.p. production-model family car and a utility vehicle (as shown in the illustration above) have been in use for some time with the new engine—and tests under normal conditions on the road have shown that the fuel consumption is very low. In the case of the family car, with a two-cylinder engine, consumption of ordinary Diesel fuel has averaged 44 miles per gallon.

For installation in vehicles where a minimum weight is desirable, the engine is being made with cast aluminium-alloy cylinder blocks, but for other purposes, such as stationary installations, where weight is unimportant, or in cases where additional weight would be an advantage, as in fork-lift trucks, cast iron will be employed.

THE FIRST FIVE YEARS OF NATIONALISED ELECTRICITY SUPPLY.

IN the course of a lecture on "Electricity Supply—the First Five Years of Nationalisation," which he delivered before the Association of Supervising Electrical Engineers on Monday, November 9, Mr. V. Clements said that the necessity for increasing the sales of electricity had at times been countered by suggestions—amounting even to a campaign—that the supply industry had reached such a size that its further expansion should be curtailed. In developing this argument its protagonists had called to their aid the need for fuel conservation and for the proper deployment of capital, and had maintained that the use of electricity should, to all intents and purposes, be reserved for power and lighting. Since its inception, however, the industry had increased its efficiency in every respect and reduced its prices for all purposes, as was shown by a comparison of the results obtained in 1922-23 and 1952-53. During that period the average cost of fuel had increased from 245*d.* to 750*d.* per ton, and the average cost per kilowatt-hour sent out from 0·3705*d.* to 0·4632*d.* The total number of kilowatt-hours sold per annum had risen from 3,762 million to 52,265 million; while the average selling price had fallen from 2·07*d.* to 1·311*d.* per kilowatt-hour. If the industry had not been allowed the freedom of growth shown by the increase in the amount sold, it was safe to assume that little if any of the higher efficiency evident in the fuel costs would have occurred; and that the average price per kilowatt-hour would have increased in close proportion to the increase in the cost of fuel. In other words, it might have been about 6*d.* per kilowatt-hour, or 4½ times its present price.

The growth of business had been two-fold, namely, in demand and electricity sold, but as the load factor showed, the percentage increase in consumption was 1½ times greater than the percentage increase in demand. Thus, while the higher demand had justified larger sets with better efficiency, the production of more electricity had justified the extra expense of plant which gave still better efficiency. This growth, with its favourable effect on fuel conservation and the resulting fuel cost (and therefore on the charges to consumers), had taken place, owing to the diversification of uses to which consumers had put electricity, all of which had contributed to the general expansion in varying degrees.

To provide for the near future, the Authority had planned to bring new plant into operation to the limit of the ability of its own and its contractors. facilities. These hopes had, however, been restricted to 1,550 MW in each of the years 1955, 1956 and 1957, and to 1,750 MW in the following years. An obvious reason for restricting new plant capacity was the need to conserve capital for other uses and to free manufacturing capacity for the export markets, to which priority of delivery was already given. Thus, this country's overseas competitors were to receive plant to increase their productivity, while home industry was starved of the means to boost its own. If, at the same time as capacity was limited, the available plant was to be restricted in its uses, its operating load factor would fall and the cost of electricity would rise still further. While the improvement in load factor could yield the greatest cost reduction, it was futile to expect that all the increased electricity output could be produced at off-peak times. Further use of electricity must create the need for more plant and it was this new plant, combined with a high load factor, which would increase the thermal efficiency and reduce both fuel, capital and administrative costs per unit of output.

There were three main ways in which economies could be made in the operating costs of generation—by the promotion of higher thermal efficiency, by cheaper transport and by the use of cheaper grades of fuel. The first was being tackled by continuous technical progress and the second had already been partly achieved by the rationalisation of the sources from which power stations derived their coal. In this way the average length of haul for

inland transport to power stations had been reduced from 36·6 miles in 1947 to 32·9 miles in 1952, and the amount carried by sea had been increased by nearly 30 per cent. Further economies in the delivered cost of fuel would be achieved (in so far as they were not negatived by increases in the cost of coal) by the siting of new stations in the East Midlands coalfield and the construction of the 275-kV super-grid. Soon after nationalisation, of the 29 million tons of coal used by the Authority about 7½ million tons were carried over 30 miles by rail, 7 million tons were transported by sea, and 0·65 million tons were transmitted as electricity. At present, out of a total of 35 million tons about 8½ million tons were carried over 30 miles by rail 9 million tons were transported by sea, and 2 million, tons transmitted as electricity. In 1960, it was expected that out of a total of 45 million tons, 9 million would be carried over 30 miles of rail, 9 million tons would be transported by sea, and 10 million tons transmitted as electricity.

The use of cheaper grade fuels had always been the industry's basic policy and had led to cheaper power and the consumption of coal for which there was no market. Arrangements had now been made to burn dust and washery slurry, which had hitherto been discarded, in specially designed stations—one at Barony in the Ayrshire coalfield and another in Yorkshire. Consideration was also being given to others in Lancashire and the Midlands. It was hoped to utilise at Barony not only the daily output of unsaleable fuel from the whole district—some 170,000 tons a year—but also that from heaps on which many hundreds of thousands of tons had been accumulated.

ELECTRONIC CHIMING INSTALLATION FOR TOWER CLOCK.

The tower of the Royal Liver Building at Liverpool, which is a well-known landmark for travellers both by sea and land, is surmounted by a clock with 25-ft. dials, which has been in operation since 1911. This clock has been silent hitherto because of the weight of the bells that would have been required, but this has now been remedied by an installation for which Messrs. Gent and Company, Limited, Faraday Works, Leicester, are responsible. This installation consists of a bell-tone generator with which amplifying equipment, control mechanism and an electric master clock are associated and all of which, with the exception of the master clock, is housed in a cabinet in the base of the tower measuring about 6 ft. by 2 ft. by 2 ft. and weighing some 150 lb. Only the comparatively light loudspeakers have, therefore, to be housed in the bell chamber.

The bell-tone generator consists of a length of special wire for each bell note which, when struck by a hammer, vibrates to the fundamental and secondary harmonic frequencies, which are necessary to obtain the characteristic tones. Near these wires are pick-ups, which are connected to pre- and main amplifiers, the latter being, in turn, connected to the loudspeakers, which have been specially designed to transmit a considerable volume of sound, especially that at the low frequencies necessary for sonority. Operation is effected by a master clock the time-keeping properties of which are controlled by a pendulum. This clock is provided with triggering gear, which is synchronised with a time element in the control mechanism, so that the bell tones are operated in the proper sequence at the quarter-hours. This mechanism is arranged so that the first, second and third quarters are struck at the precise times, while the striking of the fourth quarter is advanced sufficiently to ensure that the first stroke of the hour occurs precisely on time.

Betatron for Therapeutical Work.—A 20-MeV Betatron, which has been constructed by the Metropolitan-Vickers Electrical Co. Ltd., has been presented by them to the Christie Hospital and Holt Radium Institute, Manchester. The equipment, which has been installed in a new building, is now undergoing tests and will be the first of its kind to be employed in this country for deep-seated radio therapy.

LABOUR NOTES.

Greater productivity must be achieved by the engineering and associated industries, irrespective of the outcome of the claim of the employees in those industries for an advance of 15 per cent. in their wages. Unless Britain obtained substantial increases in production, the country would encounter serious economic difficulties, Mr. Jack Tanner, the President of the Amalgamated Engineering Union and chairman of the Trades Union Congress, warned an audience of full-time trade-union officials at Manchester on November 9. This became clear, Mr. Tanner affirmed, when it was realised that the country relied on the exports which came directly and indirectly from engineering and other industries. An instance of the dangers involved had been given recently, in which a firm had revealed that an order for 200 locomotives had been lost because the price quoted was too high.

This loss of orders from abroad was a matter which affected every employee. Germany, Japan, the United States and other countries were all competing with Britain for overseas markets. Workpeople in the engineering and associated industries were, therefore, as much concerned as any employer with the efficiency of their industries. Mr. Tanner, who was replying to a question at the annual meeting of the North-Western Regional Advisory Council of the T.U.C., said that he could not understand how trade-union officials taking part in current wage negotiations could suggest that they were not interested in higher productivity. He deprecated the attitude of those who opposed increased productivity on political grounds. There might have to be some "pretty strong negotiations" on the engineering wage claim, but productivity would have to be advanced whether anything came of the negotiations or not.

Members of the executive council of the Confederation of Shipbuilding and Engineering Unions met at York on November 12, to consider the rejection of the engineering wage claim after a second series of negotiations with the Engineering and Allied Employers' National Federation. It was decided to postpone final decisions until last Tuesday, mainly, apparently, because the Amalgamated Engineering Union had arranged to hold a delegate meeting of its own on the previous day, also to consider the rejection of the wage claim. It may be recalled, in this connection, that, of the 39 unions comprising the Confederation, the A.E.U. is the one with the largest affiliated membership. At the union's meeting, it was decided to support a proposal for a 24-hour strike throughout the industry, and this decision was referred to the Confederation. A special meeting of delegates of the Confederation, to consider further action respecting the wage claim, was due to take place in London yesterday.

Dissatisfaction among railway employees had never been greater than at the present time, officials of the three principal railway trade unions informed the Railway Staff National Tribunal on November 9. The trade-union leaders, who were presenting the unions' case for an all-round increase of 3*s.* in the pound on existing wage rates, suggested that the men's restiveness constituted a serious threat to the whole future of the industry, and that it was due to their rates of pay having fallen behind those in force in other industries. The claim, which was rejected by the Railway Executive in September, would benefit some 450,000 railway employees, including clerical and supervisory staffs, if granted in its existing form. It has been sponsored by the National Union of Railwaymen, the Associated Society of Locomotive Engineers and Firemen, and the Transport Salaried Staffs' Association, and is independent of a claim presented on behalf of 130,000 employees in railway workshops, hotels, docks and inland waterways.

Speaking on behalf of the N.U.R., Mr. J. S. Campbell, the union's general secretary, admitted that frequent wage claims must cause financial embarrassment to British Railways, but suggested that they were no worse than the constantly recurring demands for higher prices for coal, oil, sleepers and other commodities used in the railway service. He put forward four principal grounds for the claim: advances in the cost of living, the difference between railwaymen's wages and those paid to employees in other services and industries, the railwaymen's right to share in the results of more efficient and economical working, and their right to be rewarded for higher productvitity in the service.

Mr. Campbell referred to improvements in track maintenance and the handling of freight. These, and new methods of maintaining locomotives, he said, had called for greater efforts from the staff. The magnitude of the railwaymen's contribution to the increased efficiency and reduced working costs would be apparent when it was realised that the railways were operating with 40,000 fewer employees than in 1948. Mr. J. Baty, the general secretary of the A.S.L.E.F., agreed that the new claim was the fourth to be presented in that number of years, but took the view that the members of his union were worse off, relatively, than they had been at the time the railways were nationalised. The existing rates did not provide an adequate or proper standard of remuneration, having regard to the duties performed.

The cost of the wage claims then being considered would be about 31 million pounds in a full year, the Tribunal were informed by Mr. W. P. Allen, chief of establishments and staff to the British Transport Commission, on the following day. Putting the Commission's case against the wage demand, Mr. Allen said that the cost of all the claims pending would amount to approximately 39 million pounds a year, if granted in full. Further increases in wages could only be met by recourse to further advances in fares and freight charges, in order to meet the additional costs involved. He maintained that there had been no change of any real importance since October last year, when the last award was made to railway employees, to warrant a claim like that submitted, or, indeed, any claim at all. The hearing by the Tribunal, which is the arbitrating authority for disputes concerning railwaymen's wages, was concluded on November 11, when final speeches were made on behalf of both sides. It was announced that the Tribunal's decision would be made known shortly.

Representatives of the Electrical Trades Union and the National Federated Electrical Association met in London on November 10 to discuss the re-opening of negotiations for higher wages for employees in the electrical-contracting industry. No statement was issued after the meeting, which lasted for nearly three hours, but it is understood that further discussions are likely to take place in the near future. This was the first meeting between officials of the two sides of the electrical-contracting industry since the "guerrilla" strikes which took place at important building sites throughout the country in August and September last. The strikes arose out of the rejection by the employers of a claim for a substantial increase in wages, and the ensuing dispute was shortly afterwards referred to a special court of inquiry set up by Sir Walter Monckton, the Minister of Labour. In its report, presented on October 14, the court recommended that negotiations on the wage demand should be resumed and that, if no agreement could be reached, the claim should then be submitted to arbitration.

Some increase in employment has taken place in Northern Ireland during recent months, and reference to this is contained in the Queen's Speech to the two Houses of the Northern Ireland Parliament. The Speech states that it is gratifying to know that the severe unemployment which affected the textile and clothing trades last year has substantially declined. In spite of this welcome improvement, however, unemployment continues to give Ministers cause for anxiety and they are resolved to press on with their efforts to create additional opportunities for work.

THE ISODYNAMOMETER.*

By J. Wright, B.Sc.

Owing to its ready workability under office conditions, celluloid is often used for constructing models for the analysis of linear plane frames. This material obeys Hooke's Law satisfactorily over a sufficiently wide range of stress, and while it exhibits creep under constant load, the nature of the creep appears to be such that the total deflection at any instant is directly proportional to the magnitude of the load, and means of compensation are possible. T. M. Charlton[1] has recently proposed a creep-compensating technique for use with celluloid models to obtain the forces and moments in the members of the respective prototypes. It is known as the "isodynamometer" technique, although originally the instrument was called a "dynamometer." The author has carried out some tests on a celluloid model of a simple portal frame, using an isodynamometer of his own design and construction, and details of these tests, with an explanation of the theory of the technique and the accuracy of the results obtained are given in this paper.

Fig. 1.

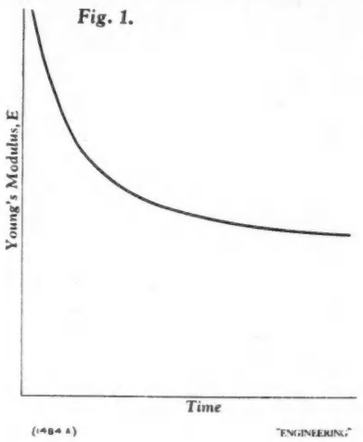
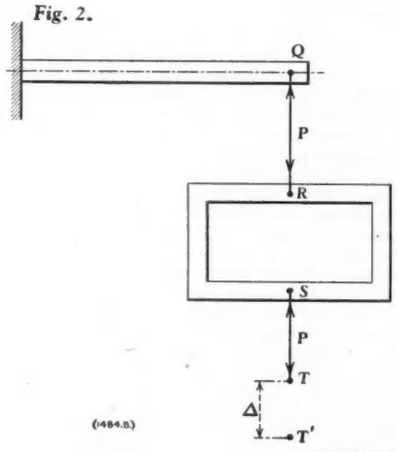


Fig. 2.



The model used for the test was made of xylonite celluloid. This material creeps very considerably under load, though its instantaneous load-deflection characteristics usually obey Hooke's Law satisfactorily for stresses which may vary from sheet to sheet but are rarely less than 2,000 lb. per square inch. (See, for example, Filon[2] and Norris.[3]) The authorities, however, are by no means unanimous about the creep characteristics of xylonite celluloid. Structural model users generally assert that the creep is such that the total deflection due to a given load, at any instant, is directly proportional to the load, and the creep thus manifests itself in an apparent gradual decrease of Young's Modulus as shown in Fig. 1. This kind of creep can be eliminated in a structural model by the incorporation of the compensating balance and the isodynamometer technique as verified by the results of the tests described.

It is most probable that the creep characteristics of xylonite deviate from this simple law at higher stresses but Charlton[4] has verified them by load-deflection tests on a cantilever specimen for maximum stresses between zero and 1,500 lb. per square inch. He found that most of the creep, amounting to nearly 10 per cent. of the instantaneous deflection, took place during the first five minutes after loading. Upon unloading instantaneously the component of the deflection representing the creep remained initially, and disappeared after a few minutes. While tests on a cantilever obscure the behaviour of fibres of the material in direct tension or compression, they are very relevant to model testing, because all of the measurable deflection of models of the kind under consideration is due to deformation in bending.

Fig. 3.(a)

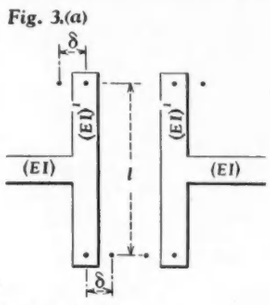


Fig. 3.(b)

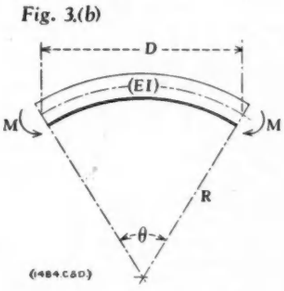


Fig. 4.

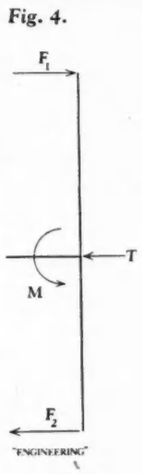


Fig. 5.

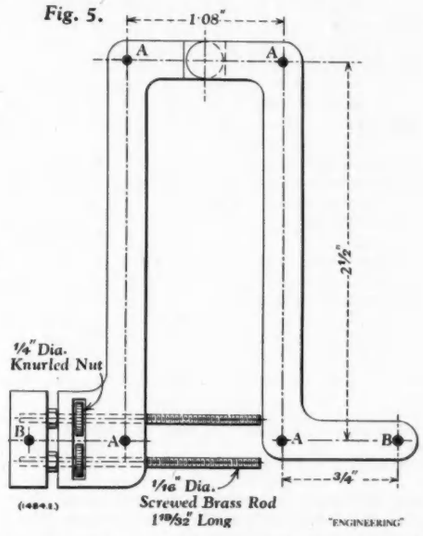
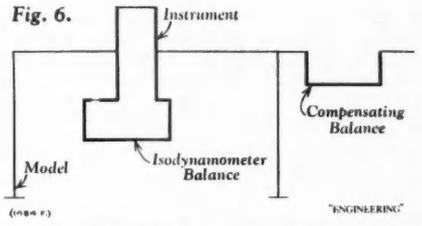


Fig. 6.



The Compensating Balance.—This is used for compensating for creep and measuring the force applied to a model, and in order to achieve this, the balance is made from the same sheet of celluloid as the model. The theory of the compensating balance has been dealt with many times, but is repeated here as an essential feature of the isodynamometer technique. Suppose that a cantilever made of celluloid is loaded through a compensating balance, as shown in Fig. 2, by applying a fixed deflection Δ to the point T, the model and the balance will deflect, and the force in the toggles Q R and S T (which must be considered infinitely stiff in comparison with the cantilever and the balance) will vary with time. If this force, denoted by P, causes the balance to deflect an amount Δ_R and the point Q on the cantilever to move through a distance Δ_Q, then on the basis of the creep characteristics described above and shown in Fig. 1,

$$\left.\begin{aligned} \Delta_R &= K_R \frac{P}{E}, \quad . \quad . \quad (a) \\ \text{and} \\ \Delta_Q &= K_Q \frac{P}{E}, \quad . \quad . \quad (b) \end{aligned}\right\} \quad (1)$$

where K_R and K_Q are constants which depend upon the dimensions of the balance and cantilever respectively. Now the deflection of the point T is :—

$$\Delta = \Delta_R + \Delta_Q$$
$$= \frac{P}{E}(K_R + K_Q),$$

from which, by transposing,

$$\frac{P}{E} = \frac{\Delta}{(K_R + K_Q)} = \text{constant}. \quad . \quad (2)$$

Thus by equations (1) and (2) it is clear that Δ_R and Δ_Q are constants and independent of time, which means that, when a fixed deflection is applied to the system, the deflection of the model and the compensating balance are also fixed by virtue of the particular creep characteristics involved.

Theory of the Isodynamometer.—The purpose of the isodynamometer is to determine the moment and thrust at a point in a structural member, due to any condition of loading. The model of the structure must be designed and constructed in such a way that the isodynamometer can be accommodated in its members. This is achieved by providing joints at suitable points within the members of the kind shown in Fig. 3(*a*). In order that a joint shall be flexurally equivalent to the length of plain member which it replaces, the dimensions of the transverse arms must be determined accordingly. Thus, suppose a moment $M = F\,l$ is applied to a joint (Fig. 3(*a*)) and to the length of plain member it replaces (Fig. 3(*b*)), the consequent rotation over the joint is $\frac{4\delta}{l}$ and the rotation over the length D of the member is $\theta = \frac{D}{R} = \frac{M\,D}{E\,I} = \frac{F\,l\,D}{E\,I}$. For flexural equivalence, these rotations must be identical, i.e.,

$$\frac{4\delta}{l} = \frac{F\,l\,D}{E\,I}. \quad . \quad . \quad . \quad (3)$$

To simplify this equation, the value of δ can be calculated approximately as the deflection of a cantilever of length $\frac{1}{2}l$, due to a point load F at its free end, thus :—

$$\delta = \frac{F}{3\,(E\,I)'}\left(\frac{l}{2}\right)^3 = \frac{F\,l^3}{24\,(E\,I)'}. \quad . \quad (4)$$

Substituting this value of δ in equation (3), and simplifying it, the following relationship is obtained :—

$$\frac{l}{6I'} = \frac{D}{I}. \quad . \quad . \quad . \quad (5)$$

If the moment at such a joint in a member of the model is M and the thrust is T, the equivalent forces F_1 and F_2 acting at distances $\frac{1}{2}l$ from the axis of the member (Fig. 4) can be expressed as follows :—

$$\left.\begin{aligned} M &= (F_1 + F_2)\frac{l}{2}, \quad . \quad (a) \\ \text{or} \\ T &= (F_1 - F_2). \quad . \quad (b) \end{aligned}\right\} \quad (6)$$

* Paper read before Section G of the British Association at Liverpool on Tuesday, September 8, 1953. Abridged.

THE ISODYNAMOMETER.

Fig. 7.

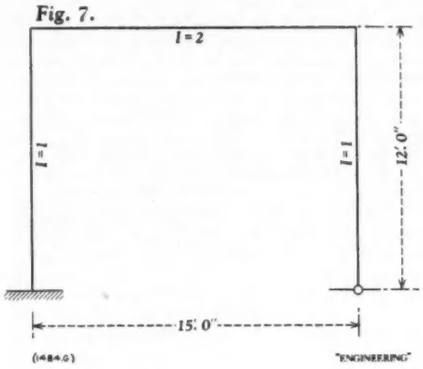


Fig. 8.

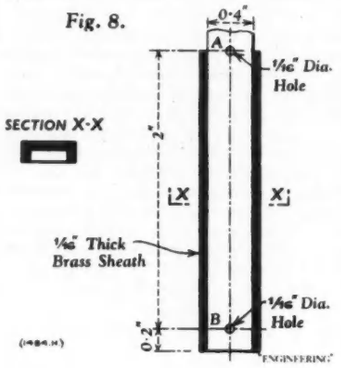


Fig. 9.

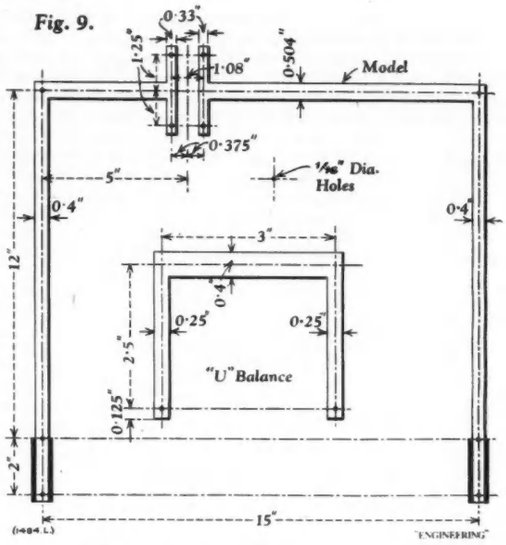


Fig. 10.

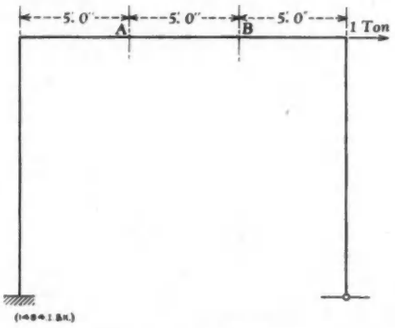
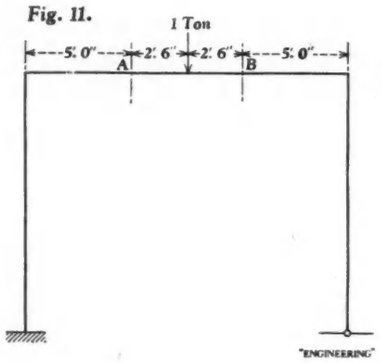


Fig. 11.



Now the isodynamometer is an instrument for measuring the forces F_1 and F_2 and hence finding the value of moment and thrust M and T. Fig. 5 illustrates the instrument designed by the author, which can be fitted at a joint of the type described above; it is held in position by four steel pins. A celluloid balance, cut from the same sheet of material as the model, is included and connected to the arms of the instrument.

The model is loaded through a compensating balance and the set-up of the model, isodynamometer and compensating balance, is shown diagrammatically in Fig. 6, page 665. The isodynamometer is adjusted before the model is loaded so that the joint arms are parallel and the model and isodynamometer are unstrained. The model is then loaded by applying a fixed deflection through the compensating balance and the isodynamometer is again adjusted until the joint bars are parallel. The deflection of the isodynamometer is then noted and the procedure repeated with the instrument inverted, using the same value of the applied deflection as before. Thus the two deflections of the isodynamometer are a measure of the forces F_1 and F_2, respectively, and can be expressed as follows :—

$$\left.\begin{aligned} \Delta_1 &= K_D \frac{F_1}{E}, \quad . \quad . \quad (a) \\ \text{and} \qquad \Delta_2 &= K_D \frac{F_2}{E}, \quad . \quad . \quad (b) \end{aligned}\right\} \quad (7)$$

where Δ_1 and Δ_2 are the two isodynamometer readings and K_D is the deflection constant of the isodynamometer which depends on the geometrical properties of the celluloid balance. By re-arranging equation (7)

$$\left.\begin{aligned} F_1 &= \frac{E\,\Delta_1}{K_D}, \quad . \quad . \quad (a) \\ \text{and} \qquad F_2 &= \frac{E\,\Delta_2}{K_D}. \quad . \quad . \quad (b) \end{aligned}\right\} \quad (8)$$

If these values are substituted in equation (6) the moment and thrust required are given by :—

$$\left.\begin{aligned} M &= \frac{E\,l}{2\,K_D}(\Delta_1 + \Delta_2), \quad . \quad (a) \\ \text{and} \qquad T &= \frac{E}{K_D}(\Delta_1 - \Delta_2). \quad . \quad (b) \end{aligned}\right\} \quad (9)$$

Now these are model values and to convert them into prototype values, it is necessary to substitute[1] a different constant K'_D instead of K_D, $m\,l$ for l, $m\,\Delta_1$ and $m\,\Delta_2$ for Δ_1 and Δ_2, as follows :—

$$\left.\begin{aligned} M_P &= \frac{E\,l\,m^2}{2K'_D}(\Delta_1 + \Delta_2) \; . \quad (a) \\ \text{and} \qquad T_P &= \frac{E\,m}{K'_D}(\Delta_1 - \Delta_2), \quad . \quad (b) \end{aligned}\right\} \quad (10)$$

where m is the layout scale factor of the model. The force applied to the prototype which produces this moment and force is

$$F_P = \frac{E\,m\,\Delta}{K'_B}, \qquad . \quad . \quad (11)$$

where K'_B is a modified balance constant and Δ is the deflection of the compensating balance. Substituting in equation (10) the expression for E given by equation (11) gives

$$\left.\begin{aligned} M_P &= F_P \frac{K'_B}{K'_D}\frac{m\,l}{2}\left(\frac{\Delta_1 + \Delta_2}{\Delta}\right) \quad (a) \\ \text{and} \qquad T_P &= F_P \frac{K'_B}{K'_D}\left(\frac{\Delta_1 - \Delta_2}{\Delta}\right). \quad . \quad (b) \end{aligned}\right\} \quad (12)$$

The value of $\frac{K'_B}{K'_D}$ is the same as the ratio $\frac{K_B}{K_D}$* and can be determined experimentally by joining the isodynamometer balance and the compensating balance together and applying a fixed deflection through both of them. The ratio $\frac{K'_B}{K'_D}$ is the ratio of their deflections.

Details of Model.—A line diagram of the frame chosen for analysis is shown in Fig. 7, which also shows the relative moments of inertia. As one foot is pinned and the other encastred, it is possible to find the moments and thrusts at two separate points on the frame by means of only one internal joint. This is explained in detail below.

A model of the frame was constructed from a sheet of xylonite celluloid 0·1 in. thick, to a linear scale of 1 in. = 1 ft. On the assumption that the contribution of the axial and shearing deflections of the members to the total deflection of the frame is negligible, it was possible to choose the second moment of area scale independently[5] as 0·4 in. depth of member for each unit second moment of area. Thus the columns were made 0·4 in. thick and the beams $0{\cdot}4 \times \sqrt[3]{2} = 0{\cdot}504$ in. deep.

The feet were designed so that either foot could be pin-jointed or encastred. This was accomplished by making the columns over 2 in. too long, sheathing the extra length in brass, and drilling holes in it 2 in. apart as shown in Fig. 8. The purpose of the brass sheath is to increase the stiffness of the additional length so that it can be considered as being rigid. If a foot is held by one pin at **A**, Fig. 8, a pinned condition is obtained. If, however, the foot is held by two pins at A and B, an encastred condition is obtained.

It was decided to determine experimentally the moment and thrust at the one third span points of the beam under two different conditions of loading, namely, a horizontal unit load acting at the top of the column, and a unit vertical load acting at the centre of the beam. For this purpose suitable joints were necessary in the two positions at which the moments and thrusts were required. A single joint located at one third of the span could be made to represent either of the one third span points of the beam, merely by interchanging the feet conditions as previously described. The method of designing the joint has already been described. Two "U" balances, one for the isodynamometer and one for the compensating balance, were cut from the same sheet of material as the model, and a dimensioned sketch of the model and balances is shown in Fig. 9.

Details of the Isodynamometer.—A dimensioned drawing of the instrument is reproduced in Fig. 5, page 665. It was made from $\frac{1}{4}$-in. sheet aluminium, the screwed rods from $\frac{1}{16}$-in. brass rod, and the knurled nuts from $\frac{1}{16}$-in. brass plate. Aluminium was chosen for its lightness, and the total weight of the instrument and pins was less than half an ounce. The instrument was connected at the joint on the model by $\frac{1}{16}$-in. diameter steel pins at the four points A. The isodynamometer balance was secured to the instrument at the two points B. The moving arm of the instrument could be made to slide either way, by the simultaneous rotation of the two knurled nuts.

As the isodynamometer was designed for application in the drawing office, all deflections were

* See reference (1).

marked on backing paper with a hard sharp pencil and measured with a ruler graduated to 0·01 in. A steel slice $\frac{3}{4}$ in. thick was used to determine when the joint regained its original position, i.e., when the arms of the joint were parallel.

Model Testing Procedure.—The model was pinned to a baseboard, and the isodynamometer attached to the joint. The load was applied through the compensating balance as previously described. One arm of this balance was attached to the loading point on the model by piano wire. A similar piece of piano wire, one end of which was sharpened, was attached to the other arm. By displacing this pointed end and pressing the sharpened end into the baseboard, the model was, in effect, loaded by a force which was represented by the deflection of the compensating balance. When the arms of the joint were brought parallel by adjustment of the instrument, the deflection of the isodynamometer balance represented the force at the joint. After the model was set up, the instrument was adjusted so that the arms of the joint were parallel, and the isodynamometer balance and the model were unstressed. This was accomplished by inserting the slice between the arms. Having confirmed that an unstressed condition prevailed, a deflection was applied as previously described, and the arms of the joint again made parallel by adjusting the moving arm of the instrument. The deflections of the compensating balance (Δ) and the isodynamometer balance (Δ_1) were noted. This procedure was repeated for five different deflections of the model, i.e., five different load values.

The isodynamometer was removed and replaced in the inverted position so that the force at the opposite end of the arms could be measured. The procedure was repeated, the same deflections being applied to the model, i.e., the sharpened end of the piano wire was inserted in the same positions as for the first part of the test. The deflections of the compensating balance (Δ) and the isodynamometer balance (Δ_2) were measured as previously described. The deflection Δ should be the same for each part of the test and where a discrepancy occurred the mean value was taken as the correct deflection. Using these values of Δ, Δ_1 and Δ_2, the moment and thrust at the position of the joint were calculated as described below. The tests were repeated with the condition of the feet reversed to give the moment and the thrust at the other third span point of the beam. Tests were also carried out to determine the moment and thrust in both positions with the other condition of loading. During testing, care was taken to eliminate the friction effect between the model and the backing paper. This was achieved by gently lifting the model free from the backing paper and allowing it to fall back gently into its deformed position.

TABLE I.

Test.	Δ (in.)	Δ_1 (in.)	Δ_2 (in.)
1	+0·100	+0·110	+0·035
2	+0·120	+0·135	+0·040
3	+0·125	+0·140	+0·040
4	+0·150	+0·165	+0·050
5	+0·175	+0·195	+0·060

TABLE II.

—	Experimental.	Theoretical.	Difference.
M (tons-in.)	21·705	21·660	+0·045
T (tons)	0·773	0·772	+0·001

TABLE III.

Test.	Δ (in.)	Δ_1 (in.)	Δ_2 (in.)
1	+0·100	+0·060	—0·020
2	+0·130	+0·075	—0·025
3	+0·150	+0·085	—0·030
4	+0·180	+0·105	—0·035
5	+0·210	+0·120	—0·040

TABLE IV.

—	Experimental.	Theoretical.	Difference.
M (tons-in.)	5·785	5·556	+0·229
T (tons)	0·775	0·772	+0·003

Details of Test.—The value of the moment and thrust within a member of the prototype can be obtained by direct substitution in equation (12). In the case of the model under consideration, $m = 12$, $F_p = 1$ ton, and $l = 2{\cdot}5$ in. As the compensating balance and the isodynamometer balance were identical, the values of K_D and K_B were identical and the ratio $\frac{K_B}{K_D}$ was unity. Substituting these values in equation (12)

$$\left.\begin{aligned} M_p &= 15\left(\frac{\Delta_1 + \Delta_2}{\Delta}\right) \text{tons-in.}, \quad \ldots \quad (a) \\ \text{and} \quad T_p &= \left(\frac{\Delta_1 - \Delta_2}{\Delta}\right) \text{tons.} \quad \ldots \quad (b) \end{aligned}\right\} \quad (13)$$

These equations can be further simplified by considering the relationship between Δ and Δ_1, and between Δ and Δ_2.

Now

$$\left.\begin{aligned} \Delta_1 &= \alpha_1 \Delta, \quad . \quad . \quad (a) \\ \text{and} \quad \Delta_2 &= \alpha_2 \Delta, \quad . \quad . \quad (b) \end{aligned}\right\} \quad (14)$$

where α_1 and α_2 are constants. Substituting these values in equation (13), the moment and thrust are given alternatively by

$$\left.\begin{aligned} M_p &= 15\,(\alpha_1 + \alpha_2) \text{ tons-in.} \quad . \quad (a) \\ \text{and} \quad T_p &= (\alpha_1 - \alpha_2) \text{ tons.} \quad . \quad . \quad (b) \end{aligned}\right\} \quad (15)$$

Test No. 1.—Fig. 10, opposite, shows the loading of the frame considered in Test No. 1, and the moment and thrust were experimentally determined for the point A. The procedure previously described was carried out and the values of Δ, Δ_1, and Δ_2 are shown in Table I. The equation relating Δ to Δ_1 and Δ to Δ_2 were determined by the principle of least squares to be $\Delta_1 = 1{\cdot}11\,\Delta + 0{\cdot}001$ and $\Delta_2 = 0{\cdot}337\,\Delta - 0{\cdot}001$ from which $\alpha_1 = 1{\cdot}11$ and $\alpha_2 = 0{\cdot}337$. Substituting the values in equation (15) $M_p = 21{\cdot}705$ tons-in. and $T_p = 0{\cdot}773$ ton. The experimental results are shown in Table II together with the theoretical results and differences, the positive sign ascribed to the differences indicating that the experimental results are greater than the theoretical results.

Test No. 2.—The model was loaded as shown in Fig. 10 and the moment and thrust determined experimentally for the point B. The measured deflections are shown in Table III and the relationship between the deflections were determined by the principle of least squares to be $\Delta_1 = 0{\cdot}58\,\Delta - 0{\cdot}001$ and $\Delta_2 = -0{\cdot}195\,\Delta$, i.e., $\alpha_1 = 0{\cdot}58$ and $\alpha_2 = -0{\cdot}195$. These values, when substituted in equation (15), yield the following results for the moment and thrust at the point under consideration.

TABLE V.

Test.	Δ (in.)	Δ_1 (in.)	Δ_2 (in.)
1	+0·105	+0·070	+0·065
2	+0·145	+0·100	+0·085
3	+0·190	+0·130	+0·115
4	+0·210	+0·145	+0·125
5	+0·225	+0·155	+0·135

TABLE VI.

—	Experimental.	Theoretical.	Difference.
M (tons-in.)	19·305	19·212	+0·093
T (tons)	0·087	0·087	0

TABLE VII.

Test.	Δ (in.)	Δ_1 (in.)	Δ_2 (in.)
1	+0·115	+0·075	+0·065
2	+0·140	+0·090	+0·080
3	+0·180	+0·120	+0·100
4	+0·200	+0·130	+0·115
5	+0·230	+0·150	+0·130

TABLE VIII.

—	Experimental.	Theoretical.	Difference.
M (tons-in.)	18·300	18·336	—0·036
T (tons)	0·086	0·087	—0·001

$M_p = 5{\cdot}785$ tons-in. and $T_p = 0{\cdot}775$ ton. Table IV shows these results together with the theoretical results and differences.

Test No. 3.—The model was set up so that the loading was vertical and the test was conducted to determine the moment and thrust at the point A, Fig. 11, opposite. The deflections Δ, Δ_1 and Δ_2 were measured and are shown in Table V. The relationships between the deflections were found to be $\Delta_1 = 0{\cdot}687\Delta - 0{\cdot}001$ and $\Delta_2 = 0{\cdot}6\Delta$, where $\alpha_1 = 0{\cdot}687$ and $\alpha_2 = 0{\cdot}6$. These values of α_1 and α_2, when substituted in equation (15), yield the following values of moment and thrust: $M_p = 19{\cdot}305$ tons-in. and $T_p = 0{\cdot}087$ ton. These values, together with the theoretical results and differences, are shown in Table VI.

Test No. 4.—This test was to determine experimentally the moment and thrust at the point B on the frame loaded as shown in Fig. 11. The same procedure was adopted for this test as for all previous tests and the measured deflections are shown in Table VII. The following relationship between the deflections was established: $\Delta_1 = 0{\cdot}653\,\Delta$ and $\Delta_2 = 0{\cdot}567\,\Delta$, i.e., $\alpha_1 = 0{\cdot}653$ and $\alpha_2 = 0{\cdot}567$. These values, when substituted in equation (15), yielded the following values for the moment and thrust: $M_p = 18{\cdot}3$ tons-in. and $T_p = 0{\cdot}086$ ton. Table VIII shows the experimental and theoretical results and the differences between them.

Conclusions.—The results of the tests described show that the isodynamometer technique is a promising addition to the model analysis methods which are already available to the structural engineer. The results compare well with the calculated values, the greatest discrepancy being 4·1 per cent. but generally were less than 1 per cent.

REFERENCES.

[1] *Civ. Eng. & P.W. Rev.*, vol. 48, No. 539, pages 51-53. January, 1953.

[2] "A Manual of Photoelasticity for Engineers," Cambridge University Press, 1936, page 87.

[3] "Experimental Stress Analysis," vol. 1, No. 2.

[4] *Civ. Eng. & P.W. Rev.*, vol. 48, No. 563, page 455. May, 1953.

[5] *Civ. Eng. & P.W. Rev.*, vol. 43, No. 507, pages 456-459. September, 1948.

PRESTRESSED-CONCRETE OFFICE BUILDING.

WHAT is believed to be the first multi-storey continuous-frame building constructed of prestressed concrete in the United Kingdom has recently been completed by the Ministry of Works as offices at Shoot Up Hill, London, N.W.2, for the London Telecommunications Region of the Post Office. The building has two floors below ground level and five above, giving a total floor area of 78,000 sq. ft. The beams were cored for the Magnel-Blaton system of prestressing, the cables passing through the columns to anchorages on the external faces of the columns, which are themselves of plain reinforced concrete. The position of the cables was such that no rotation of the beams relative to the columns occurred during prestressing, but provision was made for the development of full continuity between the several members of the frame under the full working load.

The cables were designed to keep the stresses in the concrete below 2,500 lb. per square inch in compression and 200 lb. per square inch in tension at the time of initially stressing the cables; the concrete used had a nominal mix of 1 : 2 : 4, and gave a cube strength of 5,900 lb. per square inch at 14 days. Spanning between the main beams are small secondary beams of an inverted T-section, pre-cast and pre-tensioned on the long-line system. These beams carry hollow flooring units covered by an *in situ* concrete screed and continuity was obtained in the floor system by the use of mild-steel rods in the concrete topping over the main beams. Measuring devices have been installed at various points in the structure to enable observations to be made of the deflections in the prestressed-concrete beams over a period of years in order to ascertain the extent of variations in the stresses due to the plastic flow of the concrete. The main contractors were Richard Costain, Limited, Dolphin-square, London, S.W.1.

APPLICATIONS OF SMALL GAS TURBINES.

For certain applications the low weight of the small gas-turbine engine offers advantages, in comparison with the piston engine, that offset its present high fuel consumption, e.g., for standby auxiliary power on ships or where portability is a prime consideration. In a paper entitled "The Industrial and Aeronautical Applications of the Small Gas Turbine," given before the Brough Yorkshire, branch of the Royal Aeronautical Society on November 4, Mr. F. R. Bell expressed the view that, with the development of efficient heat exchangers, the fuel consumption of the small gas turbine could be reduced to be competitive with that of the Diesel engine, and, in quantity production, the first cost should be less. Ultimately, therefore, it could be expected largely to replace the piston engine. Below a critical Reynolds number, however, the efficiency fell sharply, and the lower limit to the size of gas turbines was probably of the order of 30 to 50 h.p. The paper was based largely on his experience in developing the Rover free-turbine shaft engine and the Turboméca range of jet, free-turbine shaft, single-shaft, and air-bleed turbine engines.

After describing the general principles of existing small gas turbines, Mr. Bell considered their possible application in aircraft, industry, and road and marine transport. In aircraft, the small propeller turbine unit could be usefully applied to a short-range airliner. The small jet had applications for military training and target aircraft, but was not likely to be economical for passenger carrying. For helicopters, turbines were likely to displace piston engines completely, and he thought that the shaft drive to the rotor would probably prove to be more satisfactory than tip-jet drives. For industry, the fuel consumption of the present gas turbine was too high for it to be economical except in applications where its low first cost and light weight were particularly advantageous. Since many of these applications were specialised, the design of the engine had to be considered carefully to achieve the maximum amount of standardisation. Since industrial drives required speeds ranging from 300 r.p.m. up to 12,000 r.p.m., interchangeable gear ratios covering a wide range would need to be developed.

For automobile drives, the development of a heat exchanger was essential to provide satisfactory fuel consumption, especially at part load. Advantages of the turbine drive were its flexibility and smoothness, and a longer life between overhauls. On account of fumes, the exhaust had to be discharged clear of the vehicle, and this necessitated installing the engine at the rear with its exhaust upwards. When the fuel consumption of the turbine had been sufficiently improved, its flexibility and light weight should make it ideal for tanks and tractors. Existing small turbines were quite suitable for powering small boats of short range, and the Rover turbine-driven launch Torquil had shown a big increase in planing speed resulting from the light engine installation. The small gas turbine could be employed usefully for auxiliary plant in large ships, when it was uneconomical to carry a heavy engine for occasional use, such as power for winch drives, pumping plant in tankers, and portable fire pumps.

In the final section of his paper, Mr. Bell discussed future developments. The possibilities of using molybdenum or ceramals for turbine blades should enable higher flame temperatures to be used, considerably increasing the power output and, in conjunction with a heat exchanger, reducing the specific fuel consumption. Blade cooling also offered possibilities of higher temperatures; air cooling through the blades was not, he thought, a good method for small turbines, since the blades would be costly to produce. Spraying water on to the blades was simple and satisfactory. Another method applicable only to turbines with the blades machined integrally with the rotor was by conduction into the disc. To obtain a sufficiently high conductivity, copper or silver plating, suitably protected, might be necessary or, alternatively, blades and discs drilled and fitted with copper cores or sodium. The disc could be watercooled, or oil-cooled by a high flow of oil through the turbine shaft and around the rotor-disc hub, using oil coolers to remove the heat.

Power output could also be increased by two to three times by employing a mixed cycle in which water was sprayed into the gas between the combustion chamber and the turbine, using the whole of the air flow, at the correct air/fuel ratio, to burn the fuel. The main flow through the turbine would thus be considerably greater than that through the compressor. The gain in fuel consumption was, however, small since the heat absorbed in converting the water into steam was considerable. The system required vast quantities of water. If the difficulties associated with salt and other deposits could be overcome, the cycle might have possibilities for marine applications.

The mixed cycle in which the exhaust of the gas turbine served to fire a boiler supplying a steam turbine could not be economically applied to the small turbine. The closed-cycle gas turbine also, which required complex and bulky heat-exchangers, showed only small gains. The possibilities of atomic energy for small gas turbines could not yet be assessed; applied to automobile drives, the problems of radiation shielding appeared to be formidable.

British Plastics Federation Information Service.—The information bureau of the British Plastics Federation, founded nine years ago to provide technical information on plastics, is now dealing with over 5,000 inquiries a year. The library includes 150 technical journals from all parts of the world dealing with plastics. These journals are regularly abstracted. The abstracts are classified for reference and are also published and circulated by subscription to almost all countries of the world. Twelve monthly issues are published in two forms—printed on one side only, so that they can be pasted up into a form of card index, or printed on both sides. The charge is the same for each, i.e., 10 guineas per annum, post free, from the Federation offices, 47, Piccadilly, London, W.1.

Machine for Grinding Brake Shoes.—A special-purpose machine for grinding the surface of brake shoes, after fitting the brake lining, has been made by Arthur Scrivener, Ltd., Tyburn-road, Birmingham. In appearance it resembles a centreless grinder, but in place of the control wheel a fixture for carrying the brake shoes is fitted. The shoes are hydraulically clamped in position and the fixture rotates to and fro from its stationary position, to which it automatically returns, through an arc of 210 deg. In this way two passes are made. The makers state that 480 shoes have been ground on this machine in one hour. It is suitable for shoes ranging in size from 7 in. to 16 in. in diameter and in width from 1½ in. to 5 in. and the shoes surface can be ground to within 0·004 in. of roundness.

LIGHT MAINTENANCE GRADER.

AVELING-BARFORD, LTD., GRANTHAM.

LIGHT MAINTENANCE GRADER.

The accompanying illustration shows a light maintenance grader fitted with a 42-brake horse-power Diesel engine. It was on display at the Ministry of Works Building and Plant Exhibition and Demonstration, held at Nottingham recently, and is made by Aveling-Barford, Limited, Invicta Works, Grantham, who state that full production of this machine will commence next spring. The working weight of the grader is 8,000 lb. The machine is capable of moving large amounts of earth, and, because of its sensitive hydraulic controls, is suitable for grading to fine limits. The design incorporates an A-shaped frame mounting which transmits the thrust direct from the power axle to the blade.

The engine is a Fordson Major with four cylinders, a bore of 3·937 in., a stroke of 4·524 in. and a capacity of 220 cub. in. It develops 42·5 brake horse-power at 1,800 r.p.m. and has a maximum torque at 1,000 to 1,200 r.p.m. of 140 lb.-ft. An electric starter is fitted. The fuel tank carries 15 gallons of Diesel oil and the crankcase has a capacity of 1½ gallons. The drive is through a semi-floating differential axle of 2½-in. diameter, in which there are four pinions. The rear wheels are fitted with 11 in. by 36 in. six-ply industrial tractor tyres and the front wheels are fitted with 6 in. by 19 in. six-ply tyres. The steering wheel is 18 in. in diameter and independent foot-operated brakes are fitted to each rear wheel so that controlled power turns can be made when negotiating a bad ground surface. The brakes, which are the internal-expanding type, are fitted in 10-in. diameter drums, and a separate handbrake, which locks on to the transmission system, is provided for parking. The tractor has six forward speeds from 2·45 m.p.h. to 15·5 m.p.h. and two reverse speeds of 3·3 and 5·94 m.p.h.

The A-frame mentioned above is fabricated from 5 in. by 2½ in. channel and 5 in. by 3 in. beam section. The leg section of the blade thrust member is made from 1½-in. nominal bore steel tube and a 1¾-in. diameter fulcrum pin is fitted. The illustration shows the tractor with the blade mounted beneath the chassis and a forward-mounted bulldozing blade. The cab, which is also shown, and the bulldozing blade are both classified as extra equipment. The cab, the headroom within which is 6 ft., is made from sheet steel and fitted with safety-glass windows. The roll-down type canvas screen side is shown above the side window of the cab. Raising and lowering of the blades and angle setting are all hydraulically controlled from inside

SIDE-REGISTER CONTROL EQUIPMENT FOR REELING SHEET MATERIAL.

FERRANTI LIMITED, HOLLINWOOD.

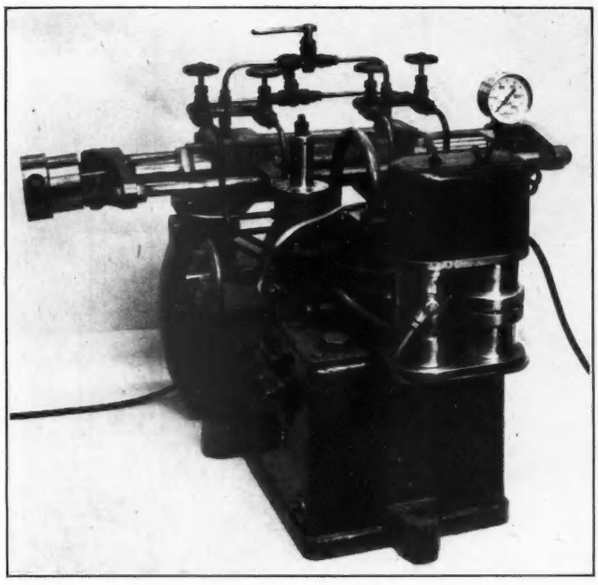
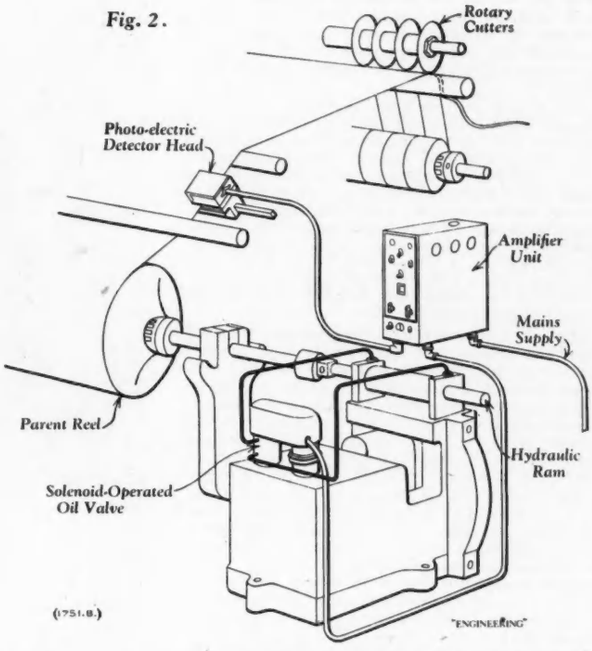


FIG. 1. HYDRAULIC UNIT WITH ELECTROMAGNETIC CONTROL.

Fig. 2.



the cab. The hydraulic pressure is provided by a Plessey gear pump operating at 1,800 r.p.m. and giving a pressure of 350 lb. per square inch.

The blade that is fitted has a width of 9 ft. and the total height of the mouldboard and bit is 1 ft. 1½ in. It has a cut below ground of 6 in., a side shift of 1 ft. either way and can be raised 7 in. above the normal ground level for clearance. The width of the bulldozer is 6 ft. and its height with bit 20 in. It provides a cut below ground of 1 in. and will lift to give 19 in. clearance. The complete tractor has an overall length of 13 ft., an overall width of 7 ft. 10 in. when the blade is set at its maximum angle, and a height of 8 ft. 3 in. with the cab fitted. Its total weight unballasted is 7,650 lb., the bulldozer and parts weigh 500 lb., and the cab 150 lb.

CONTRACTS.

MARCONI'S WIRELESS TELEGRAPH CO., LTD., Chelmsford, Essex, have received orders from the British Broadcasting Corporation for both vision and sound transmitters for the new London television station at the Crystal Palace, which will replace the existing station at the Alexandra Palace. The new station will take about two years to build. Two 15-kW vision transmitters designed for parallel operation will be provided and the effective radiated power is expected to be between 200 and 250 kW. The two 4½-kW sound transmitters which will also operate in parallel are being designed specially to meet the B.B.C.'s requirements.

THE EXPRESS LIFT CO., LTD., Northampton, have received orders from the Director of Contracts, Ministry of Transport and Civil Aviation, to supply and install, in the London Airport headquarters building, four passenger and goods lifts each having a capacity of 4,800 lb., two passenger lifts having a capacity of 3,000 lb., and two goods lifts each having a capacity of 3,450 lb.

ELECTRIC AND MUSICAL INDUSTRIES LTD., Hayes, Middlesex, have received orders from the Swiss Post Office for three complete Emitron mobile television microwave links. These links are used to relay outside-broadcast television programmes from the actual location to the main transmitter. They consist of a transmitter and receiver each with a parabolic aerial and mounting.

GILBERT GILKES AND GORDON LTD., Kendal, have received two further orders for installations for the North of Scotland Hydro-Electric Board. One of these is for the Kilmelfort scheme in Argyllshire and covers a 2,870-b.h.p. Francis turbine and a 119-h.p. auxiliary unit operating under a 340-ft. head. The second is for a 350-kW induction generator set to pass the compensation water from the Quoich Dam in the Garry scheme. Overseas orders include three 173-b.h.p. Turgo impulse wheels for the new dam at Vancouver waterworks and a 230-b.h.p. Francis turbine for the municipality of Paulpietersburg, South Africa.

PILGRIM MOBILE UNITS LTD., Ringwood, Hampshire, have received two orders for mobile trailer living units. One is from the Anglo-Iranian Oil Co. Ltd., for geological reconnaissance in East Africa and the other for the use of a pipeline crew of Costain-John Brown Ltd., in Iraq.

THE GENERAL ELECTRIC CO., LTD., are supplying, from their Fraser and Chalmers works, a complete coal-preparation plant to the National Coal Board (Durham Division) for Hordern Colliery. The contract calls for the supply of the main preparation plant, dust-collecting plant, tippler-house extensions and creepers, together with associated civil-engineering work, electrical equipment and wiring. The raw-coal screen, 6 ft. wide by 18 ft. long, will be capable of handling 210 tons of run-of-mine coal per hour.

JAMES MILLER AND PARTNERS, civil-engineering contractors, Edinburgh, have been awarded the contract to build the Lubreoch dam in Glen Lyon and to construct permanent access roads in Glen Lochay and Glen Lyon in connection with the Breadalbane Hydro-Electric Scheme of the North of Scotland Hydro-Electric Board. EDMUND NUTTALL, SONS AND CO. (LONDON) LTD., who were the contractors for the main tunnel of the Loch Sloy scheme, are to build the Stronuich dam in Glen Lyon and drive the five-mile long main tunnel from the dam to the generating station in Glen Lochay.

HUNTING GEOPHYSICS LTD., 6, Elstree-way, Boreham Wood, Hertfordshire, have been awarded a contract by the Assam Oil Co. for an airborne magnetometer survey of about 10,000 square miles in Upper Assam. The magnetic-intensity map resulting from this first survey will be interpreted by geophysicists to give a sub-surface geological diagram of the area, from which the future exploration work of the Assam Oil Co., a subsidiary concern of the Burmah Oil Co., may be decided.

THE SIEMENS AND GENERAL ELECTRIC RAILWAY SIGNAL CO., LTD., have been awarded the contract for the supply and installation of colour-light signalling on the Glasgow Central low-level lines of the Scottish Region, British Railways, between Partick Central and Strathclyde Junction, and including the branch lines from Stobcross Junction and Bridgeton Cross Junction to Kelvinbridge and Parkhead Stadium, respectively. The signalling will extend over approximately five miles.

CONTROLLING SIDE-REGISTER IN REELING SHEET MATERIAL.

To ensure the correct reeling of paper rolls or other material in operations such as slitting and re-reeling, a sensitive three-position servo mechanism, known as the Hydronic web guider, for controlling the side register accurately, has been developed recently by Ferranti Limited, Hollinwood, Lancashire, in conjunction with Messrs. C. A. Harnden, Limited, Dowson-road Engineering Works, Hyde, Cheshire. The error is detected electronically and is corrected by a hydraulic system. The servo unit is illustrated in Fig. 1. A diagram showing a typical installation is illustrated in Fig. 2.

A photo-electric detector, employing a robust all-metal photocell, observes the lateral position of the paper as it leaves the parent reel. Any deviation of the paper from the correct register causes a voltage change in the detector circuit which is amplified by a two-stage electronic amplifier. The amplified signal actuates a solenoid-operated oil valve controlling a hydraulic ram, which causes the parent reel to shift laterally to correct the error in register detected by the photo-electric head. When the paper is properly registered, no correcting signal is transmitted. The hydraulic ram and the solenoid-operated valve, together with a hydraulic pump, form a compact self-contained unit. The hydraulic power available is capable of moving loads up to 15 cwt. at a rate of 70 in. per minute, with a lateral travel of 6 in.

The Hydronic web guider will handle a wide variety of colour combinations printed on light or dark opaque paper, transparent film, foil, etc., at speeds of 1,000 ft. per minute or higher. The guiding accuracy varies with the operating conditions, but is never less than $\frac{1}{32}$ in., and in many cases may be as close as 0·01 in.

WELDING DICTIONARY.—The Institute of Welding, 2, Buckingham Palace-gardens, London, S.W.1, have announced the publication of the first part of a dictionary of welding terms in 10 languages. This part (Price 8s. net.) contains 350 terms associated with gas welding, arranged to give translations either to or from English. Other parts will be published in due course.

LAUNCHES AND TRIAL TRIPS.

M.S. "TEMPLE HALL."—Single-screw cargo vessel, built by the Caledon Shipbuilding and Engineering Co., Ltd., Dundee, for the Temple Steamship Co., Ltd. (Managers: Lambert Brothers, Ltd.), London, E.C.3. Main dimensions: 425 ft. between perpendiculars by 58 ft. 6 in. by 37 ft. 9 in. to shelter deck. Vickers-Doxford four-cylinder opposed-piston reversible oil engine, developing 3,600 b.h.p., constructed by Vickers-Armstrongs Ltd., Barrow-in-Furness. Launch, September 24.

M.S. "AUBY."—Twin-screw vessel for the carriage of cargo and first-class and unberthed passengers, built by Henry Robb, Ltd., Leith, for the Sarawak Steamship Co., Ltd., Kuching, Sarawak. Main dimensions: 212 ft. between perpendiculars by 44 ft. by 21 ft. to upper deck; deadweight capacity, about 1,170 tons on a mean draught of 11 ft. 9 in. Two four-stroke non-reversing Diesel engines, each coupled direct to propeller shafting through oil-operated reverse-reduction gears. The engines can deliver a total of 1,018 b.h.p. at 500 r.p.m., with a 2 to 1 reduction-gear ratio. Engines constructed by Ruston and Hornsby, Ltd., Lincoln. Launch, September 24.

M.S. "WILHELM JEBSEN."—Single-screw oil tanker, built and engined by Swan, Hunter, and Wigham Richardson, Ltd., Newcastle-upon-Tyne, for A/R Caloric (Paul Jebsen), Bergen, Norway. Main dimensions: 530 ft. between perpendiculars by 73 ft. by 38 ft. 10 in.; deadweight capacity, about 18,000 tons on a summer draught of 31 ft. Swan Hunter-Doxford six-cylinder opposed-piston oil engine, developing 7,500 b.h.p. at 115 r.p.m. Trial speed, 15½ knots. Trial trip, October 8.

M.S. "ORELIA."—Single-screw ore-carrying vessel, built and engined by William Gray & Co., Ltd., West Hartlepool, for Ore Carriers, Ltd., London, E.C.3. First vessel of an order for six. Main dimensions: 407 ft. between perpendiculars by 57 ft. by 33 ft. 4 in.; deadweight capacity, about 9,000 tons on a draught of 25 ft. 6 in. Two Gray-Polar five-cylinder engines, constructed by the shipbuilders' Central Marine Engine Works, coupled to a single shaft through Vulcan hydraulic clutches and reduction gearing, made by David Brown and Sons (Huddersfield) Ltd., Huddersfield. Steam supplied by two Clarkson exhaust-gas boilers and one Clarkson oil-fired boiler. Speed, 12 knots. Launch, October 9.

S.S. "GEORGE IRVIN."—Single-screw trawler, built by Cook, Welton and Gemmell, Ltd., Beverley, Yorkshire, for East Fisheries, Ltd., Cape Town. Main dimensions: 155 ft. between perpendiculars by 28 ft. by 15 ft. 3 in. to main deck; gross tonnage, 520; insulated fishroom capacity, 8,400 cub. ft. Triple-expansion steam engine, and one coal-burning Scotch boiler, constructed by Charles D. Holmes & Co., Ltd., Hull. Launch, October 12.

M.S. "FLEETBANK."—Single-screw cargo vessel, built and engined by Harland and Wolff, Ltd., Belfast, for the Andrew Weir Shipping and Trading Co., Ltd., London, E.C.3. Third vessel of a series of six for these owners. Main dimensions: 425 ft. between perpendiculars by 59 ft. by 38 ft. 3 in. to shelter deck; gross tonnage, about 5,800. Harland-B. and W. six-cylinder two-stroke single-acting opposed-piston Diesel engine. Trial trip, October 12.

S.S. "SUNBRAYTON."—Single-screw dual-purpose vessel for the transport of bauxite ore to Chaguaramas, Trinidad, and fuel oil to Mackenzie, British Guiana. Built by the Burntisland Shipbuilding Co., Ltd., Burntisland, Fife, for Saguenay Terminals, Ltd., Montreal, the steamship-owning subsidiary firm of the Aluminium Co. of Canada, Ltd. Main dimensions: 442 ft. overall by 60 ft. 6 in. by 29 ft. 6 in.; deadweight capacity, about 7,850 tons on a draught of 20 ft.; dry-cargo capacity, 305,500 cub. ft. Triple-expansion steam engine, developing 1,750 i.h.p. in service, and two oil-burning Scotch boilers, constructed by Rankin and Blackmore, Ltd., Greenock, and installed by the shipbuilders. Speed, 10 knots. Launch, October 23.

TRADE PUBLICATIONS.

Ships' Propellers.—An illustrated leaflet, reference MMD 1883, showing the successive stages in the design and production of ships' propellers has been issued by John I. Thornycroft & Co. Ltd., Smith-square, London, S.W.1. The capacity of the firm allows for making propellers up to 10 ft. in diameter and weighing 2 tons in bronze and gunmetal, or up to 17 ft. in diameter and weighing 17 tons if made solid out of cast iron.

Lamps, Bulbs and Tubes.—All three parts of the "Osram" catalogue have been re-issued by the General Electric Co., Ltd., London, W.C.2. Part I lists lamps and tubes for general and special lighting service, including the 25-W and 40-W extended candle types and the 75-W spotlight reflector lamp. Part II relates to all forms of vehicle bulbs and lamps; part III gives details of photographic and projector lamps and the G.E.C. photoflash bulbs.

PLUNGER PRESSURE GAUGE.

BRYCE BERGER, LTD., STAINES, MIDDLESEX.

FIG. 1.

Insulated Cathode Suspenders.—W. Canning & Co., Ltd., Great Hampton-street, Birmingham, 40, have published an illustrated leaflet describing the wide range of specialised component suspenders that they have developed for the silver and chromium-plating industry. The suspenders have been designed for holding batches of components, each on an independently insulated fork.

Electric-Light Bulbs.—The lamp and lighting department of the Metropolitan-Vickers Electrical Co., Ltd., St. Paul's Churchyard, London, E.C.4, have sent us a fully priced catalogue of "Metrovick" lamps, including general service bulbs, spotlight reflectors, infra-red lamps, headlights, projector lamps, sodium lamps, etc.

Special Rectifiers.—A folder has been sent to us illustrating some of the variety of special-purpose rectifiers that have been designed and built by the Edison Swan Electric Co., Ltd., 155, Charing Cross-road, London, W.C.2. The items range from a small model capable of supplying a direct-current output of 5 amperes at 24 volts to a model for starting Diesel engines by giving a direct-current output of 500 amperes also at 24 volts.

Oil Seals.—Charles Weston & Co., Ltd., Douglas Green, Pendleton, Salford, 6, have sent us their latest publication describing the full range of "O" rings now being made to B.S. No. 1806.

Miniature Circuit-Breakers.—Dorman & Smith, Ltd., Manchester, 5, have published a catalogue of their miniature circuit-breakers. These are designed to operate at currents between 2·5 and 50 amps. and up to 500 volts, alternating current. Single, double and triple-pole units are made, the dimensions of the last being 5 in. by 3 in. by 3⅛ in.

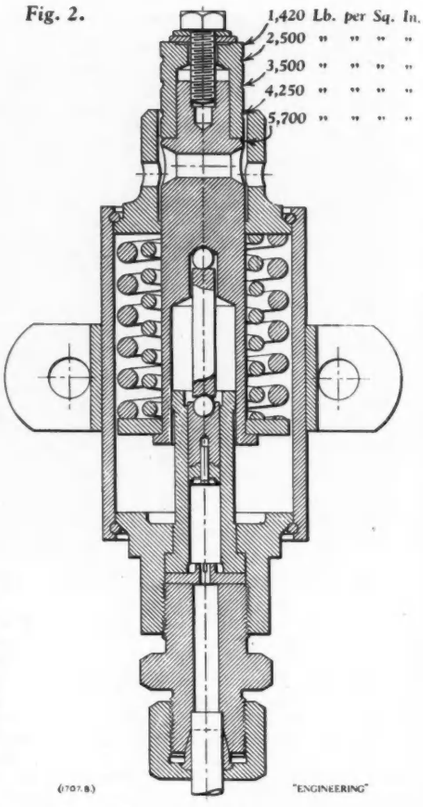
Installation and Care of Electric Motors.—A booklet dealing with the installation and care of the electric motors manufactured by them, with outputs between 1 h.p. and 40 h.p., has been published by the British Thomson-Houston Co., Ltd., Rugby. Those applying for copies are asked to write under their firm's letter heading and to indicate the type of B.T.H. machines installed in their premises.

Plastic Bench Storage Tray.—Precision Components (Barnet), Ltd., 13, Byng-road, Barnet, Hertfordshire, have sent us two illustrated leaflets describing their plastic trays for storing small parts. One leaflet deals with their model No. S.B.100, which is 7⅛ in. by 5⅛ in. and 3⅛ in. deep, is available in black, cream, red, green and standard brown phenolic material, and is designed with mating grooves to assist in stacking. The other leaflet illustrates trays of 5 in. by 4 in. by 2 in. deep with grooved side faces for mating with the next tray to it; they are also made with a width at the front of 2⅛ in. and 3⅛ in. at the back to permit semi-circular arrangement around the work area. All the trays have sloping fronts for the easy withdrawal of small parts.

German Technical Books.—We have received from Carl Hansen-Verlag, Leonhard-Eck. Strasse 7, Munich 27, a catalogue of their scientific, technical, and other publications over the past 25 years.

Self-Regulating Alternating-Current Generators.—Particulars of the self-regulating alternating-current generators manufactured by them are contained in a pamphlet issued by Higgs Motors, Ltd., Witton, Birmingham.

Fig. 2.



PLUNGER PRESSURE GAUGE.

A NEW type of pressure gauge has been developed by Bryce Berger, Limited, Ironbarks Works, Staines, Middlesex. It is robust and designed to withstand shocks better than the Bourdon type, and has been incorporated in their Handraulic starter. Fig. 1, above, shows the top of the gauge, and Fig. 2 shows a cross section. The gauge as constructed is suitable for indicating pressures between 1,500 and 5,000 lb. per square inch, such as are used on the starter; the range can be changed by using different springs. The method of operation is that the pressure of the hydraulic fluid on the piston (Fig. 2) forces the latter upwards. This movement is transmitted to the thimble by the connecting pin, which bears on balls so as to be self-centring. Movement of the thimble is controlled by the two springs. Since the travel will be directly proportional to the load, the pressure can be read by interpolation between the five calibrations on the thimble. The gauge will replace the Bourdon type which up to now has been fitted to the starter.

ELECTRICITY SUPPLY IN MECCA.—The first electricity supply system in Mecca was inaugurated by H.R.H. the Crown Prince of Saudi Arabia on Thursday, October 22. The power station, which is equipped with four Mirrlees-Brush Diesel sets with a total capacity of 3,740 kW, supplies the lighting and power load through 15 substations.

PROJECTED TYNE ROAD TUNNEL.—Detailed plans are being prepared for the Tyne Tunnel Joint Committee for the proposed road tunnel under the Tyne between Jarrow and Howdon. The consulting engineers (Messrs. Mott, Hay and Anderson, London) state that the tunnel could be built by normal tunnelling methods after the bed of the river had been treated from a pilot tunnel and a protective hood of concrete-filled heading had been constructed. The Joint Committee are seeking Government sanction to put the work in hand.

EXTINGUISHING OIL FIRES BY FOG NOZZLES.

EXTINGUISHING OIL FIRES BY FOG NOZZLES.

THE substance always available for fire-fighting on ships is sea-water, and an effective method of using it against oil fires is in the form of a fine mist or fog. Accordingly, Megator Pumps and Compressors, Limited, 43, Berkeley-square, London, W.1, arranged a demonstration in conjunction with Fire Armour, Limited, 9, George-street, Manchester-square, London, W.1, the makers of "Fognozls," to show how oil fires can be extinguished. For the first demonstration, a standard Megator pump, capable of delivery 15 tons per hour, was used to supply two hand appliances fitted with Fognozls. These are heads drilled to give many small jets, pairs of which impinge on each other to give a very fine spray or fog of droplets. Having a large surface area, these have a very rapid cooling effect on a fire and reduce the temperature below ignition point. In the demonstration, oil, in a tank about 9 ft. square, was ignited with petrol and allowed to become well alight. The two appliances were then used against it, and the flames were extinguished in about 20 seconds—almost as rapidly as the men could approach. The photograph reproduced on this page shows the fire 10 seconds after turning on the water. The pump, with its 10-h.p. Diesel engine, can be seen in the left foreground. Well under 25 gallons of water were used. In order to demonstrate the suction obtainable with the Megator pumps, the 25-ton model used in the second demonstration was mounted on a tower 23 ft. high. During the test, which was to show two ½-in. jets in operation, the suction pipe was removed from the tank for several seconds, and then replaced in order to illustrate the self-priming properties of the pump.

The third demonstration was arranged to show a fire in a machinery space where there was a fixed installation of nozzles overhead. Eight nozzles were fixed above a large transformer casing, which was mounted over an oil-tank about 8 ft. square. Again the oil was allowed to get well alight before action was taken, and the fire was extinguished in about 30 seconds. The water was supplied by the 25-ton pump used in the second test, and nearly 50 gallons were required. The small quantities of water used in the tests are a great advantage, as water damage, which can cause almost as much loss as the fire itself, is thus greatly reduced. Moreover, owing to the fineness of the spray, the water is not mixed with the oil, and can afterwards be pumped off leaving the remaining oil in a usable condition. With the fixed installation, there is no need to keep water in the pipes, so the chance of accidental operation is removed, and the water system is safer than carbon dioxide for it has not the suffocating properties of the gas. The Fognozls are designed for an operating pressure of 100 lb. per square inch but will operate at lower pressures. This method of fire fighting has now been standardised for the Swedish Navy and merchant marine.

NAVAL CONSTRUCTION IN TYNE SHIPYARDS.—The Admiralty have ordered five frigates on the Tyne and three are already under construction, two by Vickers-Armstrongs Ltd. and one by R. and W. Hawthorn, Leslie & Co., Ltd. The other two frigates will be built by Swan, Hunter and Wigham Richardson Ltd., Wallsend. No details of the ships have been released. Swan, Hunter and Wigham Richardson are also building a 26,000-ton tanker for the Admiralty. These are the first Admiralty ships to be built on Tyneside since the war.

RELAY FOR CONTROL OF REACTIVE POWER.

A RELAY designed by Chamberlain and Hookham, Limited, New Bartholomew-street, Birmingham, is intended to switch in or out sections of the static condensers employed to neutralise the lagging reactive current of an electrical load. The relay consists of two independent parts: an induction pattern mechanism, which is sensitive to the reactive volt-amperes and a switching unit driven by a reversible motor. The first is made up of two electromagnets, between which an aluminium disc rotates, and operates on the same principle as an induction wattmeter. The current and voltage coils are so connected in the load circuit that, with a balanced load and unity power factor, the voltage in the voltage coil lags 90 deg. behind the current in the current coil, the disc being held stationary by a spring. When, however, the load becomes inductive the current lags and becomes more nearly in phase with the voltage, so that a forward torque is exerted on the disc. Similarly, if the load becomes capacitive a reverse torque is developed. In each case the necessary damping is provided by two permanent magnets.

The disc carries a contact which moves between two adjustable contacts, the latter being connected to the outer ends of the voltage winding of the reversible motor forming the switching unit. This motor is also constructed like an induction watt-hour meter and incorporates a copper disc which is free to rotate between two electromagnets. One of these electromagnets is connected to the movable contacts mentioned above in such a way that only half of it is energised at any time, thus determining the direction of current flow through it. The other electromagnet is permanently energised from a secondary winding on the voltage element of the reactive volt-ampere element. The result is that the reversible motor will start when the moving contact on the reactive volt-ampere element has deflected sufficiently to touch one of the adjustable contacts, its direction of rotation depending upon which of these contacts has been brought into action, that is, upon the sign of the reactive volt-amperes in the load circuit. The reversible motor is, in turn, connected through gearing to a contact-maker which closes or opens a series of up to ten circuits depending on the direction of rotation. In this way contactors can be operated and the number of power-factor correcting condensers in the load circuit altered. This adjustment will continue until the required power factor has been obtained, a condition which is fulfilled when the moving contact has returned to its central position.

A plug bridge is mounted above the electromagnets and enables the relay to be operated at 4 per cent., 12 per cent. and 20 per cent. of its nominal full load. When the plug is withdrawn the highest setting is automatically selected, thus preventing the open-circuiting of the associated current transformers. The adjustable contacts are independently movable and are locked to their carriers by an insulated knob. They are provided with a scale, which is calibrated in units up to four on each side of a central zero. The readings on this scale are used as multipliers which must be applied to the plug settings. Thus, with the plug in the 4 per cent. position, contact settings up to 16 per cent. in either direction are obtainable.

As will be gathered, the use of light-duty contacts on the reactive volt-ampere elements makes for sensitivity, while the ample power available from the reversing motor can be employed to operate heavy-duty self-cooling contacts. These contacts have the further advantages of being easily accessible for inspection and of not being liable to breakage during transport. At each end of the heavy-duty contacts is a light-duty limit switch which interrupts the supply to the electromagnets and prevents further rotation of the disc.

The two elements of the relay may be mounted side by side or one above the other in a dust-tight cast-aluminium case of either the flush mounting or projecting type, the connections between them being made through terminal blocks, so that one can be removed without disturbing the other.

NOTES ON NEW BOOKS.

An Introduction to Railway Engineering.

By Ronald A. Inglis, B.Sc., A.M.I.C.E. Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 21*s.* net.]

This is a handbook suitable for use in the office by practising railway engineers, as well as being a textbook for railway-engineering students. It discusses, in terms that are general but adequate, modern methods of railway surveying, the construction of permanent way, and signalling so far as it concerns permanent-way assistants. The first three chapters are devoted to railway surveying and location; the fourth describes the principal permanent-way materials; succeeding chapters deal with the design and layout of railway curves, the construction of railway embankments, methods of laying trackwork and the design of turn-outs, both singly and collectively, for terminals, sidings and marshalling yards. The concluding chapter briefly describes the present practice of railway signalling. Throughout the book the subject is discussed in terms of two-rail tracks, no mention being made of the additional requirements of electrified railways as they affect the design and layout of the track; nor does the chapter on signalling attempt to discuss the subject as it applies to railways in urban areas where the traffic is dense.

Manual on Industrial Water.

A.S.T.M. Special Technical Publication No. 148. American Society for Testing Materials, 1916, Race-street, Philadelphia 3, Pennsylvania, U.S.A. [Price 4·25 dols.]

Water is a raw material of many industries and is probably used for some purpose in all, even if only for cleaning down. The statement in the first chapter of the book that "water is free in the sense that it is widespread and available for the taking" can hardly be applied directly to this country; it usually has to be paid for. It is added (rather obviously) that industry dependent on water "needs to be located near a large supply of water suitable for industrial uses." This latter statement is certainly applicable in Great Britain; one of the difficulties encountered in finding sites for large power stations, in addition to artificial ones legally created, is that adequate supplies of condensing water must be available. Its quality is not of first importance, but for many industries, particularly those concerned with food preparation, this is vital. The water supplies of this country are in general of good quality and industry probably experiences more difficulties in disposing of the surplus water which it has contaminated than in using what is delivered to it. These difficulties are not, however, the subject of this book. It is concerned with the various methods of treating raw water to make it suitable for industrial use. Rather more than half of the book consists of specifications, some of them tentative, which cover methods of sampling and of testing and analysing water for a wide variety of impurities ranging from iron bacteria to fluorine. Many of the specifications covering methods of test have been published earlier, but their assembly, together with newer matter, in a single volume will be a great convenience to, as the introduction puts it, "executives, plant managers, designers and similar technologists." The earlier part of the book consists of a series of chapters which deal with the actual procedures employed in utilising the standard specifications and methods.

Girdles for Tractor Wheels.—Tests have recently been made with a girdle which can be fitted around the large rear wheel of farm tractors to prevent wheel spin. It comprises two chains made with flat links, which pass around the outer edge of the tyre, connected together by grousers in the form of flat plates; these project radially from the wheel surface. A bearing plate, which conforms to the outer surface of the tyre and is sufficiently wide to prevent damaging its surface, is fixed beneath the grouser. Preliminary tests with a dynamometer made on a dry, loose, friable surface showed that spin normally occurred at a pull of 2,700 lb. With the grousers fitted it rose to 4,200 lb. in first gear and, in second, engine stall occurred at 3,100 lb. The designers of this equipment are Roadless Traction Limited, Hounslow, Middlesex.

SYSTEM FOR REMOTE INDICATION OF MEASUREMENTS.

A new alternating-current system for the remote indication of measurements of mechanical movements, pressures, temperatures, etc., has been introduced recently by Salford Electrical Instruments, Limited, Salford, Lancashire, in collaboration with the Research Laboratories of the General Electric Company, Limited. The system is a development of their original electro-mechanical converter system which, it may be recalled, employed as transducer a transformer in which the core was moved by the originating mechanical force, thereby causing a change of inductance in the indicating circuit. In the new system, a smaller transducer has been introduced, with a wide range of applications, including the direct measurement of 0 to 20, 0 to 50, and 0 to 100 thousandths of an inch by a spring-loaded stylus. Fig. 1 shows the transducer, used in conjunction with a diaphragm assembly, installed as a pressure transmitter in a

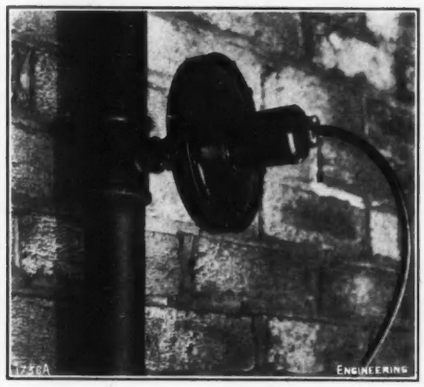
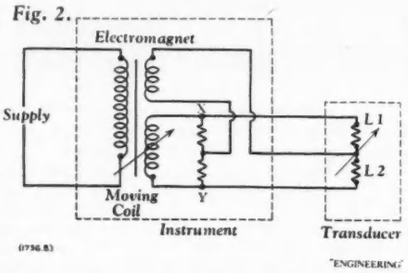


Fig. 1.

Fig. 2.



pipeline. The indicating instrument is of similar construction to a standard moving-coil switchboard instrument with 100-deg. scale. Alternatively, certain types of alternating-current potentiometric recorders may be employed.

The principle of operation may be followed by referring to Fig. 2. A change in the electromagnetic coupling at the transducer end, brought about by a movement of the stylus which alters the position of the core in the air gap, is balanced by a change in the electromagnetic coupling at the instrument. The voltage induced in the moving coil from the electromagnet depends on its angle of deflection. The voltage between X and Y, which depends on the relative values of L_1 and L_2 at the transducer, is applied to the moving coil, which will thereupon take up a position such that the electrical torque is zero. Thus for any change in the position of the core in the transducer there is a corresponding change in the position of the moving coil.

The system may be used either on a 230-volt or 110-volt 50-cycle supply. With a standard three-core cable the maximum distance between the transducer and the indicating instrument is 1,000 yards, but greater distances are permissible, provided that the resistance of any conductor is not greater than 25 ohms. The overall accuracy of the system is better than $\pm$ 1 per cent. of the full-scale deflection of the instrument, and is maintained with supply-voltage variations of $\pm$ 15 per cent., supply frequency variations of $\pm$ 7 per cent., and within the temperature range 0 to 70 deg. C. The transducer, which weighs about 1 lb., is $2\frac{1}{2}$ in. long by 2 in. in diameter. If desired a $2\frac{3}{4}$-in. diameter fixing flange may be attached. The instrument weighs 9 lb. and is 8 in. in diameter for flush mounting. Installation is simple, requiring only the connection of three wires from the instrument to the transducer, and two wires to the mains supply. Normally, no maintenance should be necessary.

The system is particularly valuable for use in gas works, water works and oil installations, enabling measurements of low-pressure line pressure down to 10 in. water gauge to be taken at many selected points and transmitted to a central control room.

BOOKS RECEIVED.

A Pocket-Book for Mechanical Engineers. By Professor David Allan Low. Edited by Bevis Brunel Low. New impression of 1948 edition. Longmans, Green and Company, Limited, 6 and 7, Clifford-street, London, W.1. [Price 17*s.* 6*d.* net.]

The College of Aeronautics, Cranfield. Report No. 75. *Note on the Development of a Trailing-Edge Flap as a Stall Detector.* By C. F. Bethwaite. The Librarian, The College of Aeronautics, Cranfield, Bletchley, Buckinghamshire. [Price 5*s.*]

The Coppersmith. Choice of Careers, New Series No. 42. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 1*s.* 3*d.* net.]

Precautions in the Use of Ionising Radiations in Industry. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 2*s.* net.]

Portugal. Ministério das Obras Públicas Laboratório Nacional de Engenharia Civil. Publication No. 32. *Alguns Problemas de Mecânica dos Solos Relativos a Pavimentação de Estradas.* By Ulpio Nascimento. No. 34. *Determinação de Tensões com Vernizes Frágeis.* By Joaquim Laginha Serafim. No. 35. *Similarity Conditions in Model Studies of Soil Mechanics Problems.* By Manuel Rocha. No. 36. *Some Results of Settlements Observations in Actual Structures and in Models.* By Manuel Rocha and José Folque. No. 38. *Aspectos Estatísticos dos Ensaios de Recepção.* By Gustavo de Castro. Laboratório Nacional de Engenharia Civil, Av. do Brasil, Lisbon, Portugal.

The Timber Industries in the U.S.A. I. *Timber and the Furniture Industry.* Organisation for European Economic Co-operation, 2, Rue André Pascal, Paris (16e). [Price 400 francs] and H.M. Stationery Office, Kingsway, London, W.C.2. [Price 8*s.*]

Plastics Progress 1953. Papers and discussions at the British Plastics Convention, 1953, edited by Phillip Morgan. Iliffe & Sons, Limited, Dorset House, Stamford-street, London, S.E.1. [Price 50*s.* net.]

The Manufacture of Iron and Steel. By D. J. O. Brandt. English Universities Press, Limited, St. Paul's House, Warwick-square, London, E.C.4. [Price 15*s.* net.]

The British Electrical and Allied Industries Research Association. Technical Report No. A/T136. *Tracking in Solid Insulating Materials: Variables in the Test for Susceptibility to Tracking.* By V. E. Yarsley, W. J. Grant, and G. C. Ives. [Price 24*s.*] No. G/T280. *Flameproof Electrical Apparatus: Flanged Joints, One Inch in Radial Breadth, in Mixtures of Ethyl Ether Vapour and Air.* By T. J. A. Brown and N. Simpson. [Price 7*s.* 6*d.*] No. G/T284. *Flameproof Electrical Apparatus: Flanged Joints, One Inch and One-Half-Inch in Radial Breadth, in Mixtures of the Vapour of Methyl Ethyl Ketone and Air.* By T. J. A. Brown and N. Simpson. [Price 10*s.* 6*d.*] No. L/T 275. *The Dielectric Properties of Polytetrafluorethylene and Polychlortrifluorethylene.* By J. V. L. Parry. [Price 6*s.*] No. L/T281. *Effects of Contamination on Structure and Properties, with Special Reference to Long-Chain Ketones.* By Dr. V. Daniel and Dr. C. Turner. [Price 6*s.*] No. N/T63. *Bitter Figures on Single Crystals of Nickel and Nickel-Iron.* By Professor L. F. Bates and G. W. Wilson. [Price 24*s.*] Offices of the Association, Thorncroft Manor, Dorking-road, Leatherhead, Surrey.

The Strength Properties of Timber. By F. H. Armstrong. Forest Products Research Bulletin No. 28. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 2*s.* net.]

Jane's Fighting Ships, 1953-54. Edited by Raymond V. B. Blackman. Sampson Low, Marston and Company, Limited, 25, Gilbert-street, London, W.1. [Price 4 guineas net.]

Fabricated Materials and Parts. By Theodore C. DuMond. Reinhold Publishing Corporation, 330, West 42nd-street, New York 36, U.S.A. [Price 6.50 dols]; and Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 52*s.* net.]